Birch Creek and Dan River Bacteria TMDL Implementation Plan

Prepared For

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Abbreviations and Acronyms

ACEP	Agricultural Conservation Easement Program
BMP	Best management practice
CCS	Council of Community Services
CDBG	Community Development Block Grant
CDC	Centers for Disease Control
cfu	colony forming unit
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CSP	Conservation Stewardship Program
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
E. coli	*Escherichia coli*
FSA	Farm Service Agency
FTE	Full Time Equivalent
GIS	Geographic Information System
HSPF	Hydrologic Simulation Program FORTRAN
IP	Implementation plan
lbs	pounds
LID	low impact development
LU	land use
MS4	municipal separate storm sewer system
N/A	not applicable
NFWF	National Fish and Wildlife Foundation
NLCD	National Land Cover Database
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
PDC	Planning District Commission
PWS	public water supply
QAPP	quality assurance project plan
SLAF	Virginia Stormwater Local Assistance Fund
SWCD	soil and water conservation district
SWPPP	Stormwater pollution prevention plan
TAP	Total Action for Progress
TDN	total digestible nutrients
TMDL	Total Maximum Daily Load
TU	Trout Unlimited
U&CF	Urban and Community Forestry
UAA	Use Attainability Analysis
UAL	Unit Area Load
USDA	United States Department of Agriculture
U.S.	United States
USFWS	United States Fish and Wildlife Service
VADCR	Virginia Department of Conservation and Recreation

VADEQ	Virginia Department of Environmental Quality
VCE	Virginia Cooperative Extension
VDACS	Virginia Department of Agriculture and Consumer Services
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
VDOF	Virginia Department of Forestry
VDOT	Virginia Department of Transportation
VOF	Virginia Outdoors Foundation
VSMP	Virginia Stormwater Management Program
WQIF	Water Quality Improvement Fund
WQMIRA	Water Quality Monitoring, Information, and Restoration Act
yr	year

EXECUTIVE SUMMARY

Monitoring performed by the Commonwealth of Virginia identified waterbodies within the Birch Creek and Dan River watersheds that did not meet the *Escherichia coli* (*E. coli*) standards and therefore did not protect the recreation beneficial use. The bacteria impaired segments were first listed as impaired on one of Virginia's 303(d) Total Maximum Daily Load (TMDL) Priority List and Reports starting in 1996. TMDLs were developed and approved for these impaired segments in 2004 and 2008. These TMDLs developed bacteria reductions necessary to meet the *E. coli* and aquatic life water quality standards, respectively. The goal of the Birch Creek and Dan River TMDL Implementation Plan (IP) is to restore water quality within these waterbodies and associated tributaries, to achieve full supporting status for the impaired segments, and to de-list the impaired segments from the Virginia 303(d) List of Impaired Waters for bacteria and aquatic life impairments.

State and Federal Requirements

The Virginia Water Quality Monitoring, Information, and Restoration Act (WQMIRA) directs Virginia Department of Environmental Quality (VADEQ) to "develop and implement a plan to achieve fully supporting status for impaired waters." To meet the requirements of WQMIRA, an IP must include the date of expected achievement of water quality objectives, measureable goals, corrective actions, and costs, benefits, and environmental impact of addressing the impairment. The federal requirements outline the minimum elements of an approvable IP. These include implementation actions and management measures, a timeline for implementation, legal or regulatory controls, time required to attain water quality standards, and a monitoring plan and milestones for attaining water quality standards. Requirements for Section 319 funding eligibility were also considered.

Review of TMDL Development

The Birch Creek and Dan River TMDL IP addresses bacteria impairments of 30 segments within 23 subwatersheds located within parts of the Counties of Carroll, Floyd, Halifax, Henry, Patrick, and Pittsylvania; the City of Danville; and the Town of South Boston. Fifteen impaired segments and associated drainage areas were originally encompassed within the 2004 and 2008 TMDL study watersheds (Birch Creek and Dan River) (VADEQ, 2004, 2008). In addition, this chapter

assigns allocations to the 15 additional bacteria-impaired segments that were not specifically included in the previously developed 2004 and 2008 TMDL reports because these segments were listed as impaired after completion of the TMDLs (i.e., nested impairments). The drainage areas for the nested impaired segments were included within the developed TMDL watershed area. Development of the bacteria TMDLs used the *E. coli* water quality standards of a geometric mean concentration of 126 colony forming units (cfu)/100 ml and a single sample concentration of 235 cfu/100 ml.

The allocation scenarios for meeting the bacteria TMDLs were updated during the IP development based on a determination of allocation loads and reductions for bacteria impaired segments that did not have an individual established TMDL and land use changes. Development of the allocation scenarios considered bacteria land uses and sources including developed, cropland, pasture/hay, forest, water/wetlands, and other land uses and input from livestock and wildlife direct loading and failing septic systems.

The reductions in bacteria loading include 100% reductions for failing septic system loads and livestock direct, and 86-97% reduction from developed and pasture land. The allocation scenarios used in this IP are presented in Table E-1.

Table E-1. Load Reductions for *E. coli*									
	Developed	**Cropland**	**Pasture/ Hay**	**Forest**	**Point source**	**Livestock Direct**	**Wildlife Direct**	**Straight Pipes and Sewer Overflows**	**Total**
Dan River	95%	95%	95%	0%	0%	100%	43%	100%	91%
Miry Creek	95%	95%	95%	0%	0%	100%	43%	100%	91%
Birch Creek	97%	97%	97%	0%	0%	100%	66%	100%	97%
Birch Creek UT	97%	97%	97%	0%	0%	100%	66%	100%	97%
Germy Creek	97%	97%	97%	0%	0%	100%	66%	100%	97%
Big Toby Creek	95%	95%	95%	0%	0%	100%	43%	100%	91%
Fall Creek	97%	97%	97%	0%	0%	100%	0%	100%	92%
Lawless Creek	97%	97%	97%	0%	0%	100%	0%	100%	92%
Sandy Creek (west)	97%	97%	97%	0%	0%	100%	13%	100%	95%
Sandy River (south)	97%	97%	97%	0%	0%	100%	33%	100%	90%
Stewart Creek	97%	97%	97%	0%	0%	100%	33%	100%	90%
Sugartree Creek	97%	97%	97%	0%	0%	100%	33%	100%	90%
Sandy River (north)	97%	97%	97%	0%	0%	100%	42%	100%	90%
Tanyard Creek	97%	97%	97%	0%	0%	100%	33%	100%	90%
Cascade Creek	95%	95%	95%	0%	0%	100%	43%	100%	91%
Stokes Creek	95%	95%	95%	0%	0%	100%	43%	100%	91%
Lawson's Creek	95%	95%	95%	0%	0%	100%	43%	100%	91%
Powell's Creek	95%	95%	95%	0%	0%	100%	48%	100%	91%
Byrd's Branch	95%	95%	95%	0%	0%	100%	39%	100%	87%
Double Creek	86%	86%	86%	0%	0%	100%	0%	100%	75%
Sandy Creek (east)	95%	95%	95%	0%	0%	100%	43%	100%	91%
Cane Creek	95%	95%	95%	0%	0%	100%	43%	100%	91%
Pumpkin Creek	95%	95%	95%	0%	0%	100%	43%	100%	91%

Public Participation

Public participation in the development of an IP is important in order to educate and inform the local stakeholders about the issues and to solicit input on appropriate solutions. Participation involved public meetings, steering committees, and smaller working groups for agricultural, government, and residential stakeholders. The public meetings were held to educate the public about the need for watershed cleanup, introduce the Birch Creek and Dan River TMDL IP and the IP development process and progress, and highlight ways for the public to get involved with the IP. The intent of the working groups was for the stakeholders to provide their specialized input concerning the watershed and best management practices. The working groups made recommendations for their areas of interest with education and outreach and funding being primary recommendations for most groups. The information and suggestions provided by each working group were used to develop the IP as applicable. The steering committee meetings were

a forum to consider the issues and recommendations of all the working groups as well as funding sources and involvement of the public. Representatives from each of the working groups presented the main comments and suggestions from their group. Additionally, technical aspects of the IP development process were discussed.

Implementation Actions

Implementation actions necessary to reduce the bacteria load and associated costs and pollutant removal efficiencies were identified through extensive stakeholder input, public participation, and review of land use/source data and pollutant delivery mechanisms. Published reference materials used include the Virginia Agricultural Cost Share Best Management Practices (BMP) Manual, Virginia Stormwater BMP Clearinghouse, and the Virginia Stormwater Management Handbook.

Quantifiable BMPs proposed in this implementation plan are grouped by the land use (i.e., agricultural, residential, or urban) or pollution source with which the BMPs are associated such as livestock or pet waste. The proposed BMPs were quantified to meet the bacteria reductions called for in the TMDLs. TMDL IPs are designed to meet TMDL pollutant reduction targets within a watershed based on land use as defined by TMDL studies. IPs may be utilized by localities for pollutant reduction strategies; however they are not considered a requirement for permit compliance. Further, IPs do not prescribe specific BMPs for localities to implement to meet their MS4 permit requirements. Site-specific analysis is required prior to the siting, design, and implementation of the BMPs.

Table E-2 presents the various BMPs proposed in the Birch Creek and Dan River TMDL IP. They include residential BMPs, stormwater BMPs, Livestock Exclusion Systems, cropland BMPs, pasture BMPs, and stream restoration. The cost associated with each BMP is also presented in Table E-2. Technical assistance for agricultural, residential, and non-MS4 urban BMPs was also evaluated and proposed.

The main benefit of implementation of the various control measures is the improvement of the water quality of Birch Creek and Dan River and its tributaries. Reducing bacteria loads will protect human health and safety, promote healthy aquatic communities, improve agricultural production, and add to the economic vitality of communities through enhancement of residential

property and opportunities for outdoor recreation. The cost-effectiveness for each BMP category considers the pollutant loads reduced per $1,000.

Table E-2. Birch Creek and Dan River TMDL IP - Proposed BMPs and Costs per BMP				
Agricultural				
BMP Type	**BMP**	**Unit**	**Cost (per unit)**	**Number of Units**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	foot	$9.49	60,355
	Livestock Exclusion for TMDL IP (SL-6)	foot	$8.79	238,401
	Livestock Exclusion for TMDL IP (LE-1T)	foot	$8.79	238,401
	Small Acreage Grazing System (SL-6AT)	foot	$3.16	18,106
	Livestock Exclusion with Reduced Setback (LE-2T)	foot	$5.98	30,177
	Stream Protection/Fencing (WP-2T)	foot	$7.38	18,106
Pasture	Manure Storage (WP-4) - Beef	acre	$58,000	131
	Woodland buffer filter area (FR-3)	acre	$700	6,406
	Vegetative Cover on Critical Areas (SL-11)	acre	$2,500	65,657
	Reforestation of Erodible Pasture (FR-1)	acre	$200	24,087
	Pasture Management (EQIP 528, SL-10T)	acre	$75	10,072
	Wet Detention Ponds (acre-treated)	acre	$150	11,746
	Grazing Land Management (SL-9)	acre	$200	2,505
Cropland	Continuous No-Till (SL-15)	acre	$100	208
	Small Grain Cover Crop (SL-8)	acre	$30	234
	Permanent Vegetative Cover on Cropland (SL-1)	acre	$175	302
	Sod Waterway (WP-3)	acre	$2,500	41
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	acre	$1,000	31
	Vegetative Cover on Critical Areas (SL-11)	acre	$2,500	135
	Reforestation of Erodible Pasture (FR-1)	acre	$200	288
Residential and Urban				
Waste Treatment	Septic System Pump-Out (RB-1)	Pump Out	$200	2,499
	Sewer Connection (Targeted Areas and RB-2)	system	$11,000	552
	Repaired Septic System (RB-3)	system	$5,000	563
	Septic System Installation/Replacement (RB-4)	system	$8,000	486
	Alternative Waste Treatment System (RB-5)	system	$16,000	244
Pet Waste	Pet Waste Education Campaign	program	$5,000	23
	Pet Waste Station	unit	$300	77
	Pet waste Composter	unit	$90	431
Urban	Bioretention	acre	$10,000	5,112
	Rain Gardens	acre	$5,000	4,904
	Infiltration Trench	acre	$6,000	3,795
	Manufactured BMP	acre	$20,000	3,210
	Constructed Wetland	acre	$2,900	4,126
	Detention Pond	acre	$3,800	2,859
	Riparian Buffer: Forest (acre-installed)	acre	$3,500	130
	Riparian Buffer: Grass/Shrub (acre-installed)	acre	$360	130
Stream Restoration				
	Stream Restoration	foot	$300	540
	Stream Stabilization	foot	$75	540

Goals and Milestones of the Birch Creek and Dan River TMDL IP

The primary goals of the Birch Creek and Dan River TMDL IP are to restore water quality in the impaired waterbodies and de-list the impaired segments from the Virginia 303(d) List of Impaired Waters for bacteria impairments. This IP describes specific implementation and water quality milestones, the link between implementation and water quality improvement, a timeline for implementation, and tracking and monitoring to measure implementation of achievements.

Implementation milestones establish the amount of control measures installed within prescribed timeframes, while water quality milestones establish the corresponding improvements in water quality that can be expected as the implementation milestones are met. The implementation of control measures proposed will take place over three stages in a 15-year timeline. The first two stages will be implemented over six years each; the final stage will be implemented over three years.

The first stage focuses on implementing the more cost-effective and commonly implemented actions such as livestock exclusion practices, crop and pasture BMPs, and septic system repairs. The third stage implements the remainder of the more expensive BMPs and helps to not violate the bacteria geometric mean criterion required by the TMDLs. The IP addresses implementation actions to reduce the human-induced sources of bacteria and does not address wildlife reductions both direct and indirect in the TMDLs.

Part of the staged implementation process includes the targeting of more specific locations for BMP implementation. Specific analysis within the Birch Creek and Dan River targeted subwatersheds for on-site sewage disposal, urban riparian zone creation, urbanized area for maximum reductions via stormwater BMPs, and livestock exclusion practices.

Implementation tracking and monitoring are two actions used to evaluate changes in the watershed and progress toward meeting water quality milestones. Implementation actions should be tracked to ensure that BMPs are adequately installed and maintained. BMP tracking would include quantification of the various BMPs identified in the IP and a reporting of the applicable units that are installed in each subwatershed. VADEQ would focus monitoring efforts on the original listing stations for the bacteria impairments.

Stakeholders Roles and Responsibilities

Stakeholders are individuals or groups who live or have land management responsibilities in the watershed, including federal, state and local government agencies, special interest groups, and citizens. Stakeholder participation and support is essential for improving water quality and removing streams from the impaired waters list. These stakeholders worked together to develop the Birch Creek and Dan River TMDL IP through meeting attendance, comments and suggestions on various aspects of the plan, and through the provision of watershed and water quality data. In the future, many will also play a role in the implementation of the control measures described in the IP.

Federal government stakeholders include the U.S. Environmental Protection Agency (EPA) and the Natural Resources Conservation Service (NRCS). EPA oversees the Clean Water Act programs and NRCS provides technical expertise and financial resources to both private stakeholders and government agencies for conservation of natural resources.

Currently, there are six state agencies that have a major role in regulating and/or overseeing statewide activities that impact water quality. These include: VADEQ, Virginia Department of Conservation and Recreation (VADCR), Virginia Department of Agriculture and Consumer Services (VDACS), Virginia Department of Health (VDH), Virginia Department of Forestry (VDOF), and Virginia Cooperative Extension (VCE). VADEQ is the lead state agency in the TMDL process. The other agencies administer water quality related programs and provide technical and financial assistance for water quality improvement projects and BMPs. VADEQ, VADCR, and VDH participated in the TMDL IP development process.

Local government groups work closely with state and federal agencies throughout the TMDL process; these groups possess insights about their community that may help to ensure the success of TMDL implementation. The Pittsylvania and Halifax soil and water conservation districts (SWCD) work closely with watershed residents such as farmers, ranchers and other land users on understanding and implementing conservation practices. The West Piedmont Planning District Commissions (PDC) promotes the efficient development of the regional physical, social, and economic resources. City and county government staff work closely with PDCs and state

agencies to develop and implement TMDLs, promote education and outreach to stakeholders on the TMDL process, and can enact ordinances that reduce water pollutants and support BMPs.

Community watershed and conservation groups offer opportunities for river and land conservation groups to share ideas and coordinate preservation efforts. These groups have a valuable knowledge of the local watershed and river habitat that is important to the implementation process and are also a showcase site for citizen action. Citizens are involved in the TMDL and IP processes through participation in public meetings, assistance with public outreach and education, provision of local watershed history, and/or implementation of BMPs on their property to help restore water quality. Community civic groups perform a wide range of community service including environmental projects where they assist in the public participation process, educational outreach, and with implementation activities in local watersheds. Animal clubs and associations provide a resource to assist and promote conservation practices among farmers and other land owners especially in rural areas and urban areas where pet waste has been identified as a source of bacteria in water bodies.

Integration with Other Watershed Plans

Water quality issues and improvement in the Birch Creek and Dan River watersheds is a component of many different organizations, programs and activities. Examples of these voluntary and regulatory efforts include watershed implementation plans, TMDLs, Roundtables, Water Quality Management, Erosion and Sediment Control Regulations, Stormwater Management Programs, Source Water Assessment Programs, local comprehensive and strategic plans, and local environmentally-focused organizations. Efforts in the Dan River watershed that coincide with the goals of the Birch Creek and Dan River TMDL IP include various watershed-wide plans, local comprehensive plans, legal authority, and monitoring.

Frequently regional and local plans and programs focus on watershed attributes such as natural resources, water quality and quantity, stormwater, and public education. These endeavors focus resources on protecting and improving the natural environment and educating the public about watershed problems. Voluntary citizen monitoring programs educate the public about water quality issues and can assist in the listing or delisting of impaired waters, TMDL development,

tracking the progress of implementation plans, and identifying waters for potential future VADEQ monitoring.

Potential Funding Sources

Funding that may be available to support the Birch Creek and Dan River TMDL IP include:

Federal

- Federal Clean Water Act Section 319 Incremental Funds
- EPA Water Infrastructure Finance and Innovation Act (WIFIA) Funds
- United States Fish and Wildlife Service (USFWS) grants
- United States Department of Agriculture (USDA) – Farm Service Agency (FSA)
    - Conservation Reserve Program (CRP)
    - Conservation Reserve Enhancement Program (CREP)
- USDA – Natural Resources Conservation Service (NRCS)
    - Conservation Stewardship Program (CSP)
    - Environmental Quality Incentives Program (EQIP)
    - Agricultural Lands Easement Program
    - Regional Conservation Partnership Program (RCPP)

State

- Virginia Agricultural Best Management Practices (BMPs) Cost-Share Program
- Virginia Agricultural Best Management Practices Tax Credit Program
- Virginia Clean Water Revolving Loan Fund
- Virginia Department of Environmental Quality Citizen Water Monitoring Grant Program
- Virginia Outdoors Foundation (VOF)
- Virginia Department of Forestry
    - Urban and Community Forestry Assistance Program (U&CF)
    - Virginia Forest Stewardship Program
- Virginia Department of Environmental Quality
    - Virginia Small Business Environmental Compliance Assistance Loan Fund
    - Virginia Stormwater Local Assistance Fund (SLAF)
    - Virginia Water Quality Improvement Fund

Regional and Private

- Community Development Block Grant (CDBG)
- National Fish and Wildlife Foundation (NFWF)
- Five Star and Urban Waters Restoration Grant Program
- Southeast Rural Community Assistance Project (SERCAP)
- RiverBank Fund
- Virginia Environmental Endowment
- Wetland and Stream Mitigation Banking
- Virginia Tobacco Region Revitalization Commission Grant Programs
- Duke Energy Water Resources Fund

1.0 Introduction

The Clean Water Act (CWA) requires that streams, rivers, and lakes within the United States meet specified water quality standards and that states conduct monitoring to identify waterbodies that are polluted and do not meet these standards. When streams fail to meet the standards, Section 303(d) of the CWA and the U.S. Environmental Protection Agency's (EPA) Water Quality Management and Planning Regulation (40 CFR Part 130) requires states to develop a Total Maximum Daily Load (TMDL) for each pollutant. A TMDL determines the maximum amount of pollutant loading that a waterbody can receive without exceeding the appropriate water quality standards. After a TMDL is developed, states work with local stakeholders to develop an implementation plan to address the pollutant sources impairing the waterbody and meet the TMDL. The ultimate goal is to remove the polluted waterbody from the impaired waters list.

Required monitoring performed by the Commonwealth of Virginia identified waterbodies within the Birch Creek and Dan River watersheds (Figure 1-1) that did not meet the *Escherichia coli* (*E. coli*) criteria and therefore did not protect the beneficial uses of primary contact recreation. A TMDL was established and approved for the Birch Creek impaired segments in 2004 and for the Dan River impaired segments in 2008 (VADEQ 2004, 2008) (Table 1-1). Since the development of these TMDLs, additional segments were identified as impaired due to exceedances of *E. coli* criteria.

The implementation plan includes both the segments identified in the TMDLs and the additional segments. The additional impaired segments were not included in the 2004/2008 TMDLs and therefore do not have established TMDLs. Instead they were "nested" within the existing TMDL already developed by Virginia Department of Environmental Quality (VADEQ) to estimate the pollutant load allocations. The new impairments can be "nested" when it is determined that the impairment has the same sources as a previously listed impairment within an existing TMDL Impairment nesting rationale is explained further in "*Water Quality Assessment Guidance Manual for 2014 305(b)/303(d) Integrated Water Quality Report*" (VADEQ, 2014). The Birch Creek and Dan River Watersheds Implementation Plan (IP) addresses both the 13 established and 17 additional nested impaired segments (Table 1-1; Figure 1-1).

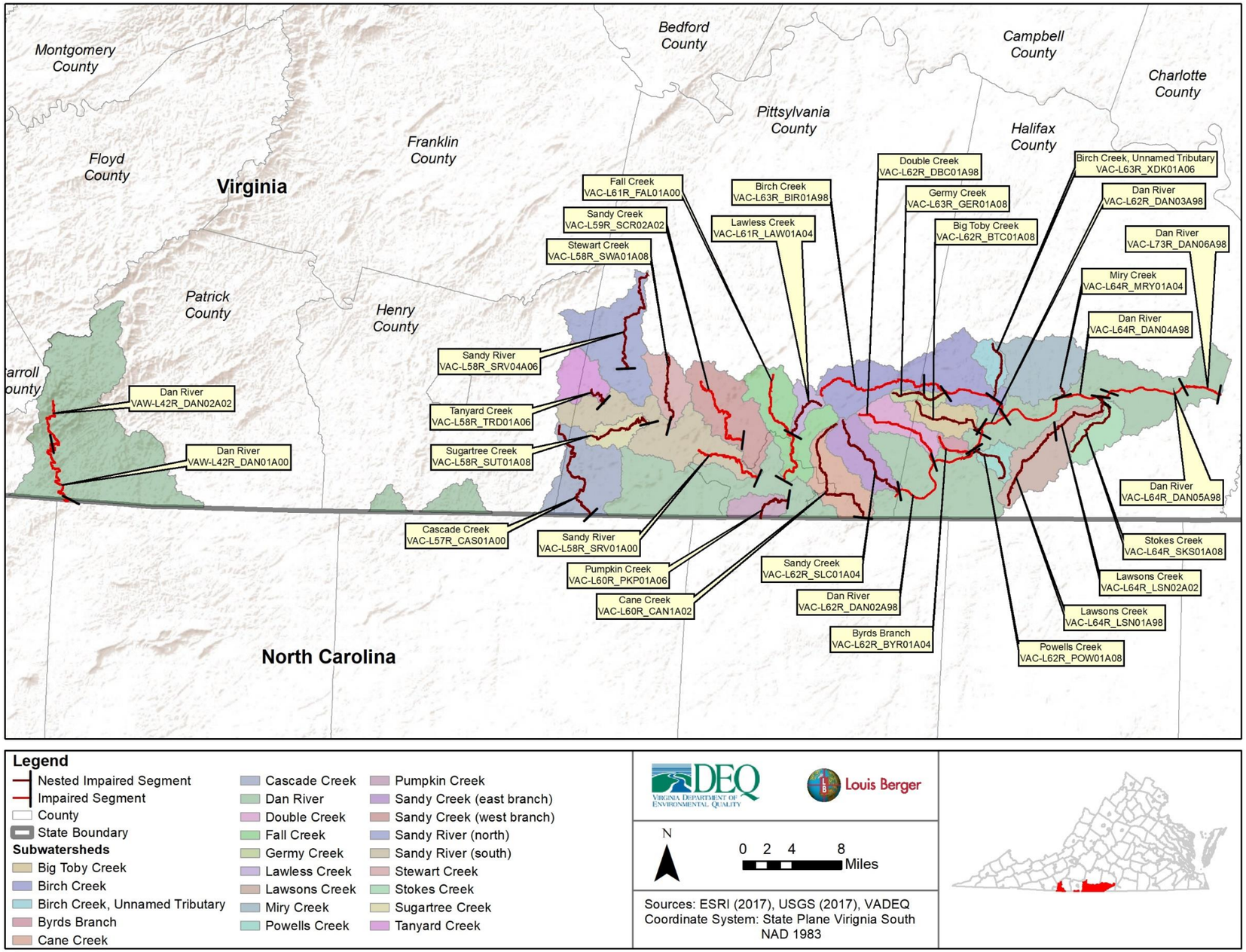

Figure 1-1. Birch Creek and Dan River Watersheds and Bacteria Impaired Segments addressed in the Implementation Plan

Table 1-1: Impaired Segments in Birch Creek and Dan River Watersheds			
Stream Name	**Length (mi)**	**TMDL**	
		Established	**Nested**
Segments identified as impaired in 2004/2008 TMDLs			
Birch Creek	20.1	●	
Byrds Branch	3.8	●	
Dan River (7 segments)	50.6 (total)	●	
Double Creek	8.9	●	
Fall Creek	12.0	●	
Sandy River (south)	7.23	●	
Sandy Creek (west)	9.49	●	
Segments identified as impaired after 2004/2008 TMDLs			
Big Toby Creek	7.6		●
Birch Creek, Unnamed Tributary	5.4		●
Cane Creek	12.3		●
Cascade Creek	11.8		●
Germy Creek	5.4		●
Lawless Creek	4.7		●
Lawsons Creek (2 segments)	15.5 (total)		●
Miry Creek	1.1		●
Powells Creek	4.6		●
Pumpkin Creek	4.3		●
Sandy Creek (east)	9.41		●
Sandy River (north)	10.79		●
Stewart Creek	7.3		●
Stokes Creek	6.4		●
Sugartree Creek	7.0		●
Tanyard Creek	2.9		●

Source: (VADEQ 2014)

1.1 Purpose of the Implementation Plan

After development and approval of a TMDL, certain measures and actions must be implemented to reduce the bacteria load entering the impaired waterbodies and to ultimately meet the *E. coli* water quality standards. The TMDL provides the foundation for pollutant reduction measures and actions.

The Birch Creek and Dan River Watersheds IP describes the measures through a staged process necessary to reduce the bacteria sources contributing to the impaired waterbodies. These measures include better treatment technology, best management practices (BMPs), and

educational and outreach programs. The purpose of the Birch Creek and Dan River Watersheds IP is to reduce bacteria to the levels stated in the TMDLs and to restore the waterbodies to conditions that support the primary contact recreational uses. The staged IP should allow for cost-effective reductions in bacteria loads as well as improve opportunities for stakeholders to receive financial and other assistance for implementation activities.

Staged implementation is an iterative process that first addresses those pollutant sources with the largest impact on water quality. Generally, the first stage of implementation for bacteria TMDLs in Virginia is attaining the de-listing goal, which means that the Single Sample Maximum (SSM) criterion is not violated more than 10.5% of the time. The second stage is full implementation of the TMDL, which in more recent TMDLs equates to not violating the geometric mean.

1.2 Implementation Plan Components

Components discussed in the IP include:

- State and federal requirements for implementation plans;
- Review of the 2004/2008 TMDL studies including descriptions of the watersheds and associated land use, the impairments, water quality monitoring performed and data collected, modeling details, pollutant sources and existing loads, and updated allocations and load reductions based on new land use data;
- Consideration of impaired segments not specifically separated out in the 2004/2008 TMDLs;
- Public participation process including steering committee, working group, and public meetings;
- Implementation actions including identification of existing or future BMPs and other management activities, determination of BMP reduction efficiencies, quantification of type and numbers of new control measures required, and cost-effectiveness analysis;
- Measurable goals and milestones for attaining water quality standards including timelines for implementation and corresponding achievement of water quality improvements, number and type of implementation measures installed in each timeframe, and monitoring of these milestones;

- Roles and responsibilities of watershed stakeholders including outreach and educational actions;
- Description of other watershed plans and ongoing activities that could support implementation efforts; and
- Potential funding sources for implementation actions.

1.3 Impairment Listing

The Birch Creek and Dan River Watersheds IP covers a watershed area of approximately 760 square miles including 23 subwatersheds with 30 impaired segments. The impaired segments are listed as impaired in Virginia's 303(d) TMDL Priority List and Reports (VADEQ, 2014). Table 1-1 provides a summary of the 30 impaired segments; these segments are identified in further detail in Table A-1 in Appendix A. As stated above, 13 segments have established TMDLs. For the 17 additional segments, the drainage area and associated pollutant loads were estimated during hydrologic and water quality modeling performed for the established TMDLs in VADEQ (2004, 2008). Bacteria source assessments and pollutant load allocations for these 17 segments were developed using a Unit Area Load and the estimated levels of bacteria reductions for the established TMDLs.

1.3.1 Applicable Water Quality Standards

Water quality standards consist of designated uses for a waterbody and water quality criteria necessary to support those designated uses. According to Virginia's Water Quality Standards (9 VAC 25-260-5), the term water quality standard means the following:

> *"…provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."*

1.3.2 Designated Uses

According to Virginia's Water Quality Standards (9 VAC 25-260-10):

> "*All state waters, including wetlands, are designated for the following uses: recreational uses, e.g., swimming and boating; the propagation and growth of a balanced, indigenous population of aquatic life, including game fish, which might reasonably be expected to inhabit them; wildlife; and the production of edible and marketable natural resources, e.g., fish and shellfish.*"

The 30 impaired segments do not support recreational uses based on the water quality monitoring data.

1.3.3 Applicable Water Quality Criteria

The water quality standards used for the 2004/2008 TMDL studies were based on fecal coliform bacteria counts. However, effective February 1, 2010, VADEQ specified a new bacteria standard in 9 VAC 25-260-170.A, using *E. coli* bacteria. This standard replaced the existing fecal coliform standard of 9 VAC 25-260-170. For a waterbody to be in compliance with Virginia bacteria standards for primary contact recreation in freshwater, the current criteria are as follows:

> *"E. coli bacteria shall not exceed a monthly geometric mean of 126 CFU [colony forming units]/100 ml in freshwater. If there are insufficient data to calculate monthly geometric means in freshwater, no more than 10% of the total samples in the assessment period shall exceed 235 E. coli CFU/100 ml."*

1.3.4 Wildlife Contributions

The previously established bacteria TMDLs demonstrate that the existing wildlife bacteria loads in many of the subwatersheds are often greater than the allocated bacteria loads. This indicates that removal of all bacteria sources, except wildlife, would not allow the stream to attain the required water quality standard. Neither the Commonwealth of Virginia nor EPA is proposing the elimination of wildlife to allow for the attainment of water quality standards. Not only is this an impractical action but the reduction of wildlife or the changing of natural background conditions is not the intended goal of a TMDL IP.

Addressing bacteria loads from wildlife is neither feasible nor addressed in this implementation plan. Therefore, the Birch Creek and Dan River Watersheds IP intends to use an adaptive implementation approach consisting of an iterative process to enhance the existing monitoring

plan as well as to implement reasonable and practicable control actions. If, after implementation of these control actions, exceedances of the water quality standard persist due to wildlife loadings, then a special study called a Use Attainability Analysis (UAA) may become necessary. A UAA could address the removal and re-designation of the existing designated use. The UAA involves the data collection and analyses of various factors (e.g., physical, chemical, biological, and economic) affecting the attainment of the designated use as described in the federal regulations under 40 CFR §131.10(g).

2.0 State and Federal Requirements for Implementation Plans

There are a number of state and federal requirements and recommendations for TMDL IPs. This chapter defines these and states if the elements are a required component of an approvable IP or are a recommended topic that should be covered in a thorough IP. The chapter has three sections that discuss (a) the requirements outlined by the Water Quality Monitoring, Information, and Restoration Act (WQMIRA) to produce an IP that is acceptable and approvable by the Commonwealth, (b) EPA recommended elements of IPs, and (c) required components of an IP in accordance with Section 319 guidance.

2.1 State Requirements

The TMDL IP is a requirement of Virginia's 1997 WQMIRA §62.1-44.19:4 to 19:8 of the Code of Virginia. WQMIRA directs VADEQ to *"develop and implement a plan to achieve fully supporting status for impaired waters."* To meet the requirements of WQMIRA, an IP must include the following:

- Date of expected achievement of water quality objectives;
- Measureable goals;
- Necessary corrective actions;
- Associated costs, benefits, and environmental impacts of addressing the impairment.

2.2 Federal Requirements

Section 303(d) of the CWA and current EPA regulations do not require the development of implementation strategies. However, EPA does outline the minimum elements of an approvable IP in its 1999 "Guidance for Water Quality-Based Decisions: The TMDL Process" (EPA, 1999).

The listed elements in the EPA guidance (EPA, 1999) include:

- Description of the implementation actions and management measures;
- Timeline for implementing these measures;
- Legal or regulatory controls;
- Time required to attain water quality standards; and
- Monitoring plan and milestones for attaining water quality standards.

2.3 Requirements for Section 319 Funding Eligibility

Congress amended the CWA in 1987 to establish the 319 Nonpoint Source Management Program. Under Section 319, States, Territories, and Indian Tribes receive grant money, which supports a wide variety of activities including the restoration of impaired waters. The EPA develops guidelines that describe the process and criteria to be used to award CWA Section 319 nonpoint source grants to states. The guidance is subject to revision and the most recent version is to be considered for IP development. The "Nonpoint Source Program and Grant Guidelines for States and Territories in FY 2013" identifies the following nine elements that must be included in the IP to meet the 319 requirements:

1. Identify the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed-based plan;
2. Estimate the load reductions expected to achieve water quality standards;
3. Describe the nonpoint source (NPS) management measures that will need to be implemented to achieve the identified load reductions;
4. Estimate the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement the watershed-based plan;
5. Provide an information/education component that will be used to enhance public understanding of the project and encourage the public's participation in selecting, designing, and implementing NPS management measures;
6. Provide a schedule for implementing the NPS management measures identified in the watershed-based plan;

7. Describe interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented;
8. Identify a set of criteria for determining if loading reductions are being achieved and progress is being made towards attaining water quality standards and if not, the criteria for determining if the watershed-based plan needs to be revised; and
9. Establish a monitoring component to evaluate the effectiveness of the implementation efforts.

For more information on the requirements for Section 319 fund eligibility, refer to:

- *http://www.deq.state.va.us/Programs/Water/WaterQualityInformationTMDLs/NonpointSourcePollutionManagement.aspx*
- *https://www.epa.gov/nps/319-grant-program-states-and-territories*

3.0 Review of TMDL Development

The Birch Creek and Dan River TMDL IP addresses bacteria impairments of 30 segments within 23 subwatersheds located within parts of the Counties of Carroll, Floyd, Halifax, Henry, Patrick, and Pittsylvania; the City of Danville; and the Town of South Boston. Fifteen impaired segments and associated drainage areas were originally encompassed within the 2004 and 2008 TMDL study watersheds (Birch Creek and Dan River) (VADEQ, 2004, 2008). In addition, this chapter assigns allocations to the 15 additional bacteria-impaired segments that were not specifically included in the previously developed 2004 and 2008 TMDL reports because these segments were listed as impaired after completion of the TMDLs (i.e., nested impairments). Pollutant load allocations were established by the Hydrologic Simulation Program FORTRAN (HSPF) model used in the original TMDL development; the allocations are described in Section 3.1.1.1.

This chapter includes a review and summary of the 2004 and 2008 bacteria TMDL development studies. In addition, pollutant load allocations were updated using the most current land use data.

3.1 Update of TMDL Allocation Loads

Current land use distributions have changed since the 2004 and 2008 TMDLs were developed. Therefore, for the purpose of the Birch Creek and Dan River TMDL IP development, adjustments were made to the bacteria TMDLs to reflect the land uses changes, using the 2011 National Land Cover Database (NLCD). These adjustments were conducted specifically for the IP, and are not official TMDL modifications.

3.1.1 Bacteria Load Revision

3.1.1.1 Original Water Quality Modeling

The two bacteria TMDL studies used the Hydrologic Simulation Program FORTRAN (HSPF) model to simulate the hydrology and bacteria fate and transport in the various reaches of the Birch Creek and Dan River watersheds. HSPF is a hydrologic, watershed-based water quality model that explicitly accounts for the specific watershed physical conditions, variations in rainfall and climate, and the various bacteria sources. Development of the bacteria TMDLs used

the *E. coli* water quality standard of a geometric mean concentration of 126 colony forming units (cfu)/100 ml and a single sample concentration of 235 cfu/100 ml.

During the development of the bacteria TMDLs, the project area was divided into smaller subwatersheds to represent the local watershed conditions and to improve the accuracy of the model. Using the existing conditions within these subwatersheds, the model was run until allocation scenarios were obtained by iteratively running the model, while adjusting source contributions, until the model runs resulted in attainment of the *E. coli* water quality standard.

3.1.1.2 Land Use Adjustments

Established Impaired Segments

In both bacteria TMDL studies, the 2001 NLCD was used to develop the land use distributions, perform hydrology and water quality calibrations, and develop the allocations. However, most subwatersheds experienced substantial changes in the land use distributions since 2001 (**Table 3-1**); those changes were addressed by adjusting the various bacteria sources and allocations using the 2011 NLCD land use layer. In general, between 2001 and 2011, the area of developed and pasture lands increased, and forested areas decreased.

As stated, the existing and allocated loads were adjusted to reflect the most recent land use conditions. The adjusted loads are presented for each subwatershed in Section 3.2. The adjustment to the 2011 land use conditions of the existing and allocated bacteria loads uses a Unit Area Load (UAL – cfu/acre) approach and consists of the following steps:

- The 2001 land use distribution and the 2001 bacteria allocations were used to develop a UAL for each land use category and source.
- For the direct bacteria sources, agricultural land areas were used to develop the UAL for direct livestock, and forested areas were used to develop the UAL for direct wildlife.
- Direct septic loads presented in the 2004 and 2008 TMDLs were not changed, as it was assumed that an increase in developed land would not substantially increase the septic load because most new development would be expected to connect to the sewer network or install functioning septic systems.

Table 3-1. 2001 and 2011 Land Use Distributions							
Sub-watershed	**Landuse**	**Developed**	**Cropland**	**Pasture/Hay**	**Forest**	**Water/ Wetlands**	**Total**
Dan River	NLCD 2001	20,499	761	51,864	126,755	5,987	205,866
	NLCD 2011	20,843	762	58,002	120,013	6,246	205,866
	% Change	2%	0%	12%	-5%	4%	
Byrd's Branch	NLCD 2001	88	16	510	1,185	13	1,812
	NLCD 2011	95	10	629	1,066	12	1,812
	% Change	8%	-37%	23%	-10%	-10%	
Double Creek	NLCD 2001	277	75	2,198	6,610	52	9,212
	NLCD 2011	312	54	3,623	5,171	52	9,212
	% Change	13%	-28%	65%	-22%	0%	
Fall Creek	NLCD 2001	4,240	269	6,236	13,083	69	23,897
	NLCD 2011	4,646	96	8,001	11,093	61	23,896
	% Change	10%	-64%	28%	-15%	-12%	
Sandy Creek (west)	NLCD 2001	2,635	205	6,545	11,230	40	20,655
	NLCD 2011	3,023	87	8,313	9,194	37	20,654
	% Change	15%	-57%	27%	-18%	-7%	
Sandy Creek (east)	NLCD 2001	817	87	4,110	7,132	92	12,238
	NLCD 2011	805	72	4,692	6,571	98	12,238
	% Change	-1%	-17%	14%	-8%	7%	
Birch Creek	NLCD 2001	1,439	162	9,060	21,514	628	32,803
	NLCD 2011	1,433	151	11,384	19,180	656	32,803
	% Change	0%	-6%	26%	-11%	4%	
Big Toby Creek	NLCD 2001	273	81	3,140	4,141	47	7,681
	NLCD 2011	273	81	4,116	3,159	53	7,681
	% Change	0%	0%	31%	-24%	13%	
Birch Creek, UNT	NLCD 2001	144	0.00	1,392	3,131	87	4,754
	NLCD 2011	140	0	1,662	2,864	87	4,754
	% Change	-2%	0%	19%	-9%	0%	
Cane Creek	NLCD 2001	1,583	76	4708	6709	110	13,186
	NLCD 2011	1,755	111	5,529	5,681	110	13,186
	% Change	11%	47%	17%	-15%	0%	
Cascade Creek	NLCD 2001	664	22	5,731	14,450	52	20,919
	NLCD 2011	659	22	7,906	12,280	52	20,919
	% Change	-1%	0%	38%	-15%	-1%	

Table 3-1 (cont'd). 2001 and 2011 Land Use Distributions

Sub-watershed	Landuse	Developed	Cropland	Pasture/Hay	Forest	Water/ Wetlands	Total
Germy Creek	NLCD 2001	157	20	865	1,835	14	2,891
	NLCD 2011	144	26	990	1,716	14	2,891
	% Change	-8%	30%	14%	-6%	0%	
Lawless Creek	NLCD 2001	386	47	1,175	2,285	5	3,898
	NLCD 2011	386	47	1,552	1,902	11	3,898
	% Change	0%	0%	32%	-17%	104%	
Lawsons Creek	NLCD 2001	1,435	76	6,470	8,159	739	16,879
	NLCD 2011	1,421	73	7,451	7,177	758	16,879
	% Change	-1%	-5%	15%	-12%	3%	
Miry Creek	NLCD 2001	1,015	43	5,819	11,380	474	18,731
	NLCD 2011	1,026	38	7,090	10,098	478	18,731
	% Change	1%	-10%	22%	-11%	1%	
Pumpkin Creek	NLCD 2001	2,527	13	532	2,108	8	5,187
	NLCD 2011	2,539	11	607	2,022	8	5,187
	% Change	0%	-9%	14%	-4%	0%	
Stewart Creek	NLCD 2001	547	40	3,760	4,699	29	9,075
	NLCD 2011	605	40	4,232	4,169	29	9,075
	% Change	11%	0%	13%	-11%	0%	
Stokes Creek	NLCD 2001	716	48	2,511	4,736	327	8,337
	NLCD 2011	691	43	3,610	3,700	293	8,337
	% Change	-3%	-10%	44%	-22%	-11%	
Sugartree Creek	NLCD 2001	338	7	1,363	3,497	5	5,210
	NLCD 2011	338	7	2,049	2,810	5	5,210
	% Change	0%	0%	50%	-20%	0%	
Tanyard Creek	NLCD 2001	296	19	3,557	4,832	36	8,741
	NLCD 2011	296	19	3,735	4,654	36	8,741
	% Change	0%	0%	5%	-4%	-1%	
Powell's Creek	NLCD 2001	230	6	1,452	2,138	13	3,838
	NLCD 2011	230	6	1,575	2,015	13	3,838
	% Change	0%	-4%	8%	-6%	1%	
Sandy River (south of Hickory Forest Creek)	NLCD 2001	2,967	80	9,508	16,472	64	29,091
	NLCD 2011	3,116	79	10,630	15,199	68	29,091
	% Change	5%	-1%	12%	-8%	6%	
Sandy River (north of Bawley Branch)	NLCD 2001	1,050	45	7,878	16,082	81	25,135
	NLCD 2011	1,067	60	9,907	14,014	87	25,135
	% Change	2%	34%	26%	-13%	8%	

Nested Impaired Segments

Bacteria source assessments were developed within this IP for 15 nested impaired segments (Table 1-1). Allocation loads for each impaired segment without an established TMDL were developed by using the estimated level of *E. coli* reductions from the original Birch Creek and Dan River TMDLs as a guide. The existing conditions and allocation loads developed for the impaired segments without an established TMDL were then adjusted to the 2011 land use conditions. *E. coli* existing conditions and allocations loads for all the impaired segments (established and nested TMDLs) were adjusted on an area basis (i.e., based on the proportion of the nested watershed to the overall watershed of the original TMDL).

3.1.1.3 Waste Load Allocation Adjustments

Additional sources of bacteria have been permitted in Dan River, Fall Creek, Sandy River, and Sandy Creek since the development of the 2004 and 2008 TMDLs (Table 3-2). The Waste Load Allocations (WLAs) for these watersheds was updated in the sections below to reflect these new sources. This information is included in the IP for informational purposes only; reductions to permitted point sources of bacteria are not proposed in this IP.

Table 3-2. New Permitted Discharges of Bacteria Since TMDL Development

Watershed	Permit Type	Facility Name
Dan River	VPDES Individual Permit	Danville City - Northside
	VPDES Individual Permit	Maple Ave WWTP
	Domestic Sewage General Permit	Property
	VPDES Individual Permit	Residence
	Domestic Sewage General Permit	Residence
	Domestic Sewage General Permit	Residence
Fall Creek	Domestic Sewage General Permit	Residence
Sandy Creek	VPDES Individual Permit	Country Oaks LLC
Sandy Creek	Domestic Sewage General Permit	Residence
Sandy River	Domestic Sewage General Permit	Residence

3.2 Bacteria TMDL Subwatersheds

The effective watershed area of the IP covers 23 subwatersheds with 30 impaired segments (Figure 1-1; Table 1-1; Appendix A-1). The watershed areas for the IP encompasses the 2004 and 2008 TMDLs (Birch Creek and Dan River) as well as the nested segments that were not specifically included in the development of the previous TMDLs. The 2004 report developed a bacteria TMDL for Birch Creek (VADEQ, 2004); the 2008 report developed bacteria TMDLs for the Dan River, Byrds Branch, Double Creek, Fall Creek, Sandy Creek (Western Branch), and Sandy River (South) (VADEQ, 2008). Although a specific TMDL was only developed for the Dan River, Byrds Branch, Double Creek, Fall Creek, Sandy Creek (western branch), Sandy River (south), and Birch Creek watersheds, the drainage areas for the other subwatersheds in this IP were included within the developed TMDL watershed areas. The Dan River watershed from the TMDL report encompassed the bacteria impaired segments and drainage areas for the nested segments of Big Toby Creek, Cane Creek, Cascade Creek, Germy Creek, Lawless Creek, Lawsons Creek, Miry Creek, Powells Creek, Pumpkin Creek, Stewart Creek, Stokes Creek, Sugartree Creek, and Tanyard Creek. The Birch Creek watershed from the TMDL report encompassed the bacteria impaired segments and drainage areas for the nested segment of Birch Creek, Unnamed Tributary.

3.2.1 Dan River

Description of Watershed and Impairment

The Dan River subwatershed covers portions of Carroll, Floyd, Halifax, Henry, Patrick, and Pittsylvania Counties, the City of Danville, and the Town of South Boston (Figure 3-1. Beginning in Patrick County, the Dan River flows south across the Virginia-North Carolina state line. It reenters Virginia just west of the City of Danville, flows around the City before again crossing into North Carolina. Shortly after the Dan River again enters Virginia in southwestern Halifax County, it is considered impaired; it flows northeast to the Kerr Reservoir. Some reaches of the Dan River are not impaired. The impaired segments are located mainly in Patrick and Halifax Counties with a small segment in Pittsylvania County. The drainage area of this subwatershed is approximately 205,866 acres. The dominant land uses (NLCD 2011) consist of forest (58%) and pasture/hay (18%). There are also developed land uses (10%) especially in

Pittsylvania and Halifax Counties associated with the City of Danville and the Town of South Boston.

Segments of the Dan River were first identified as impaired for *E. coli* in the 2002 305(b)/303(d) Water Quality Assessment Integrated Report (VADEQ, 2002). Between January 1998 and December 2002, five out of 13 samples (38%) collected at Station 4ADAN042.80 exceeded the *E. coli* instantaneous criterion of 235 cfu/100 mL, and three out of 13 samples (23%) collected at Station 4ADAN015.30 exceeded the *E. coli* instantaneous criterion of 235 cfu/100 mL. Since its initial listing, the single sample maximum has been exceeded in 10 of 64 samples (16%) at Station 4ADAN075.22, 5 of 24 samples (21%) at Station 4ADAN053.40, and 18 of 62 samples (29%) at Station 4ADAN015.30.

Table 3-1. Impairment Summary for Dan River

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L62R_DAN02A98	11.86	Mineral Springs Branch to Route 658 bridge.	*Escherichia coli*
VAC-L62R_DAN03A98	2.81	Route 658 bridge to Birch Creek.	
VAC-L64R_DAN04A98	10.53	Birch Creek to South Boston raw water intake location.	
VAC-L64R_DAN05A98	6.58	South Boston raw water intake location to Banister River.	
VAC-L73R_DAN06A98	3.3	Dan River from the Banister River (watershed boundary) to the Peter Creek confluence (Kerr Reservoir)	
VAW-L42R_DAN02A02	5.81	Dan River mainstem from the Squirrel Creek mouth upstream to the Pinnacles Power House	
VAW-L42R_DAN01A00	9.67	Dan River mainstem from the VA/NC State Line upstream to the Squirrel Creek mouth on the Dan River	

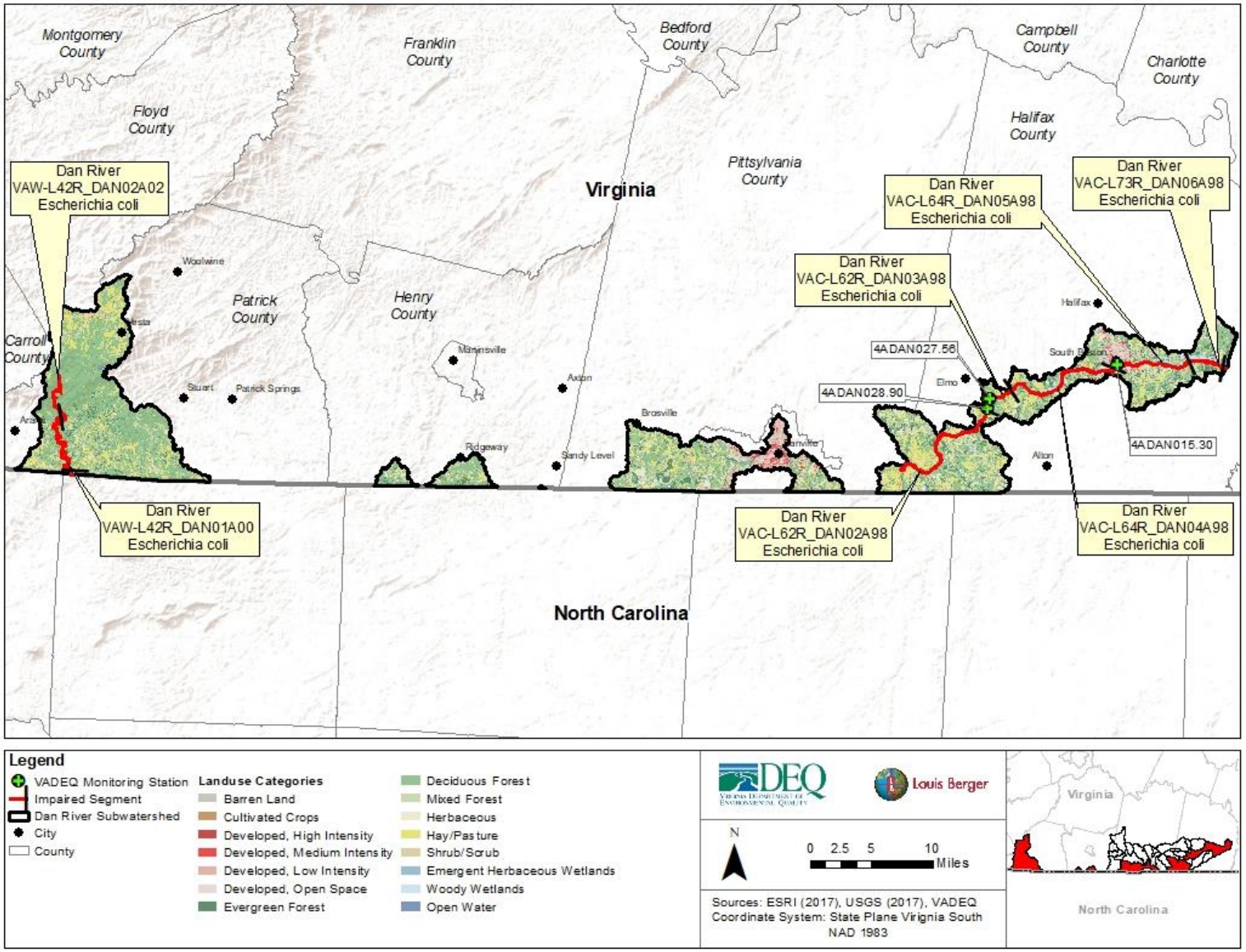

Figure 3-1. Dan River Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Dan River subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-2).

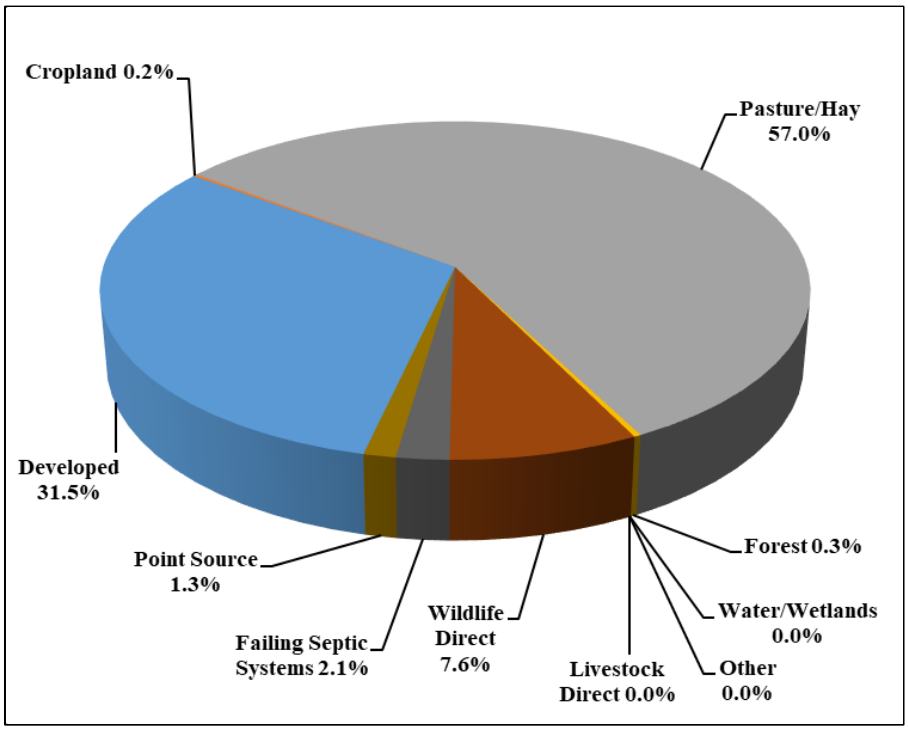

Figure 3-2. Bacteria Sources in Dan River Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Dan River subwatershed (Table 3-4).

Table 3-2. Dan River Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.01E+15	1.01E+14	95%
Cropland	1.36E+13	6.79E+11	95%
Pasture/Hay	3.64E+15	1.82E+14	95%
Forest	1.76E+13	1.76E+13	0%
Livestock Direct	5.55E+10	0.00E+00	100%
Wildlife Direct	4.83E+14	2.77E+14	43%
Failing Septic Systems	1.34E+14	0.00E+00	100%
Point Source	8.22E+13	1.13E+12	0%
Total	**6.38E+15**	**5.80E+14**	**91%**

3.2.2 Birch Creek

Description of Watershed and Impairment

Birch Creek is located in Halifax and Pittsylvania Counties (Figure 3-3). The creek flows east before its confluence with the Dan River. The subwatershed drains approximately 32,803 acres. The dominant land uses (NLCD 2011) are forest (58%) and pasture/hay (18%). Small portions of herbaceous land (10%) are located throughout the watershed.

Segments of Birch Creek were first listed as impaired in VADEQ's 2002 Section 303(d) Total Maximum Daily Load Priority List and Report due to exceedances of the fecal coliform bacteria water quality standard (400 cfu/100 ml instantaneous criterion). Following the initial listing, an *E. coli* standard was established, and subsequent listings were based on exceedances of the *E. coli* single sample maximum of 235 cfu/100 ml. Five monitoring stations showed exceedances of the 235 cfu/100 ml *E. coli* single sample maximum; the exceedances for these five stations were six out of 11 samples, five out of 11 samples, six out of 11 samples, four out of 12 samples, and two out of 11 samples. Due to these exceedances, the primary contact recreation use was not supported along 20.1 miles of the waterbody (Table 3-5).

Table 3-3: Impairment Summary for Birch Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L63R_BIR01A98	20.14	From its headwaters to its mouth on the Dan River	*Escherichia coli*

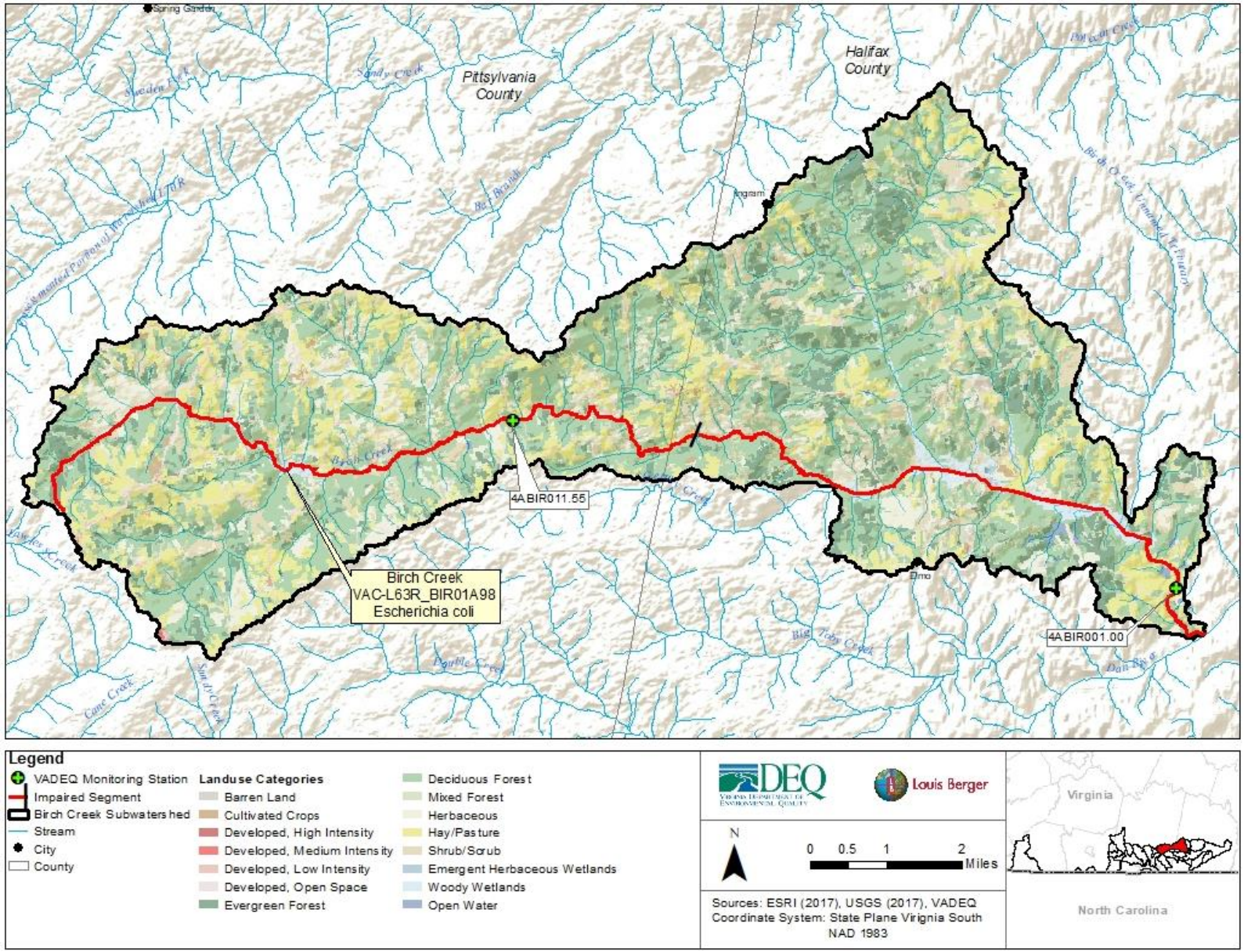

Figure 3-3. Birch Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Birch Creek subwatershed is nonpoint source runoff from developed land use (Figure 3-4).

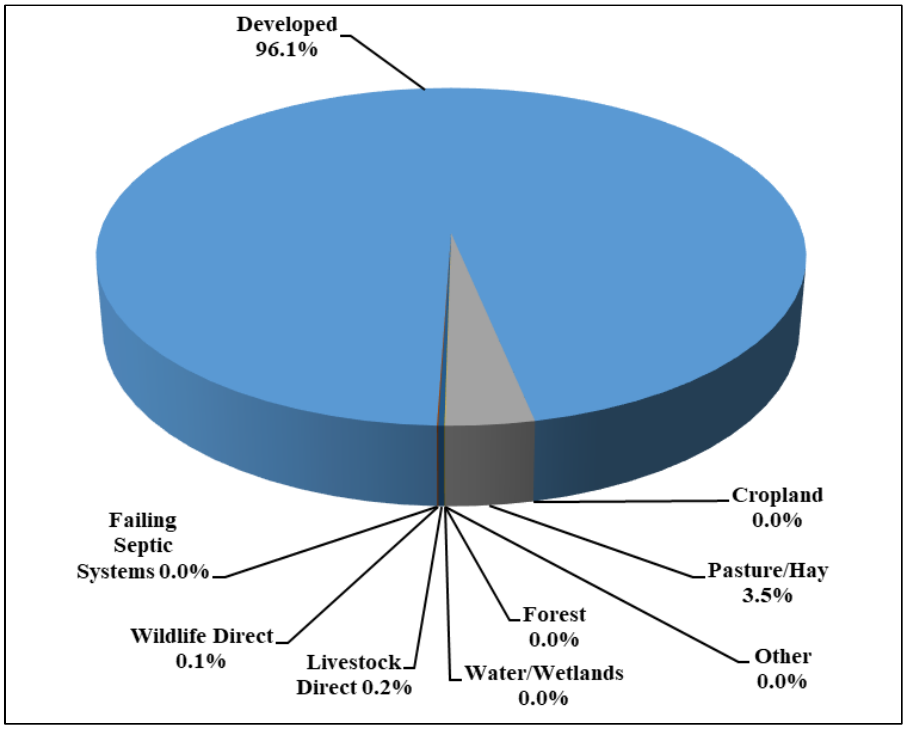

Figure 3-4. Bacteria Sources in Birch Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Birch Creek subwatershed (Table 3-6).

Table 3-4. Birch Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	3.15E+15	9.44E+13	97%
Cropland	5.19E+09	1.56E+08	97%
Pasture/Hay	1.16E+14	3.47E+12	97%
Forest	8.08E+11	8.08E+11	0%
Livestock Direct	8.00E+12	0.00E+00	100%
Wildlife Direct	1.76E+12	6.00E+11	66%
Failing Septic Systems	5.57E+09	0.00E+00	100%
Total	**3.27E+15**	**9.93E+13**	**97%**

3.2.3 Big Toby Creek (Nested)

Description of Watershed and Impairment

Most of the Big Toby Creek subwatershed is located in Halifax County with a small portion within Pittsylvania County (Figure 3-5). The headwaters of the creek are located in western Pittsylvania County, and from there the creek flows east into Halifax County and eventually drains into the Dan River. The drainage area of the subwatershed is approximately 7,681 acres. The dominant land uses (2011 NLCD) are forest (41%) and pasture/hay (31%). Small portions of herbaceous lands (14%) are also located throughout the watershed.

Big Toby Creek was first listed as impaired in VADEQ's 2008 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, six out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 7.57 miles of the waterbody (Table 3-7).

Table 3-5. Impairment Summary for Big Toby Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L62R_BTC01A08	7.57[1]	Big Toby Creek from its headwaters to its mouth on the Dan River	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report (VADEQ, 2014)

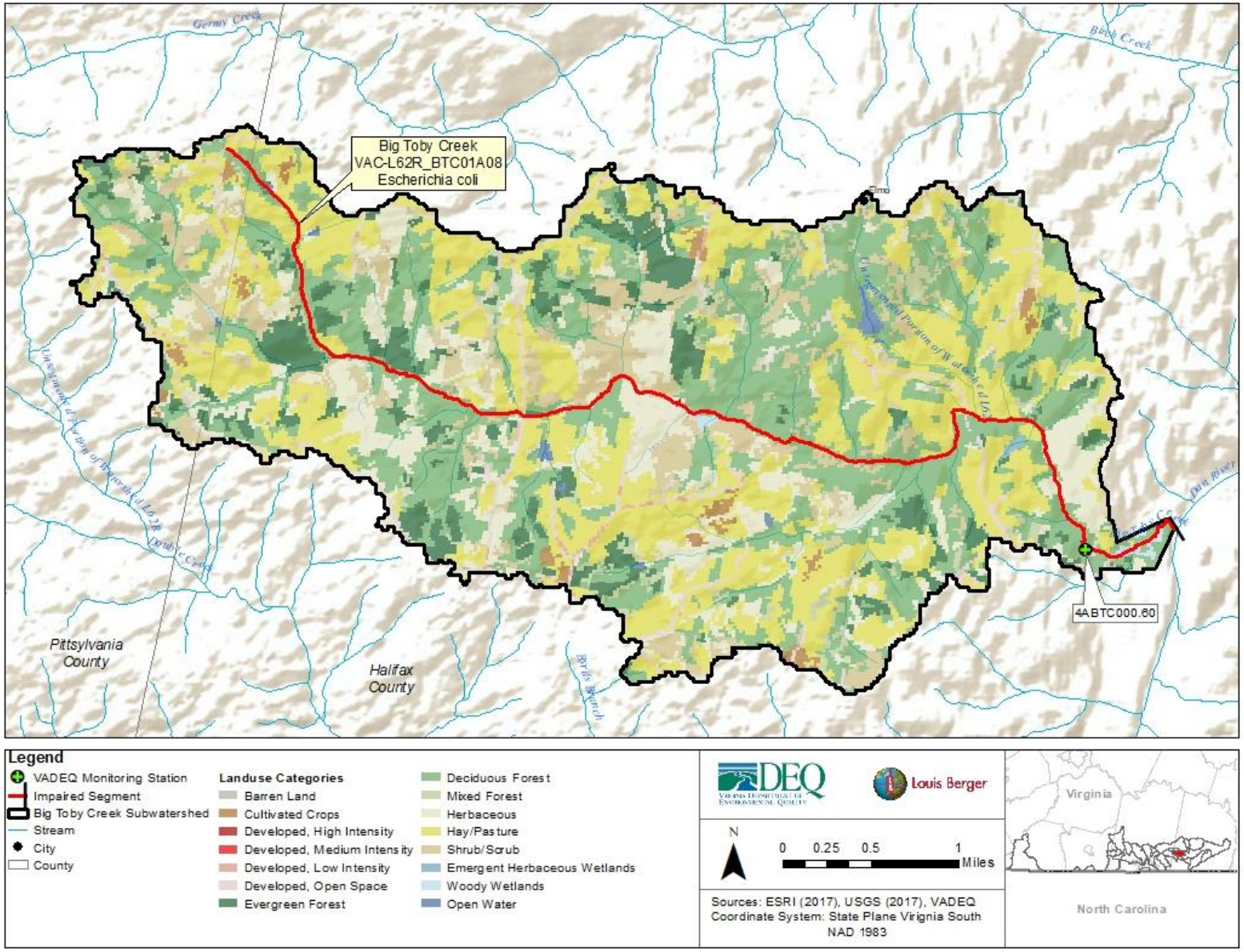

Figure 3-5. Big Toby Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Big Toby Creek subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-6).

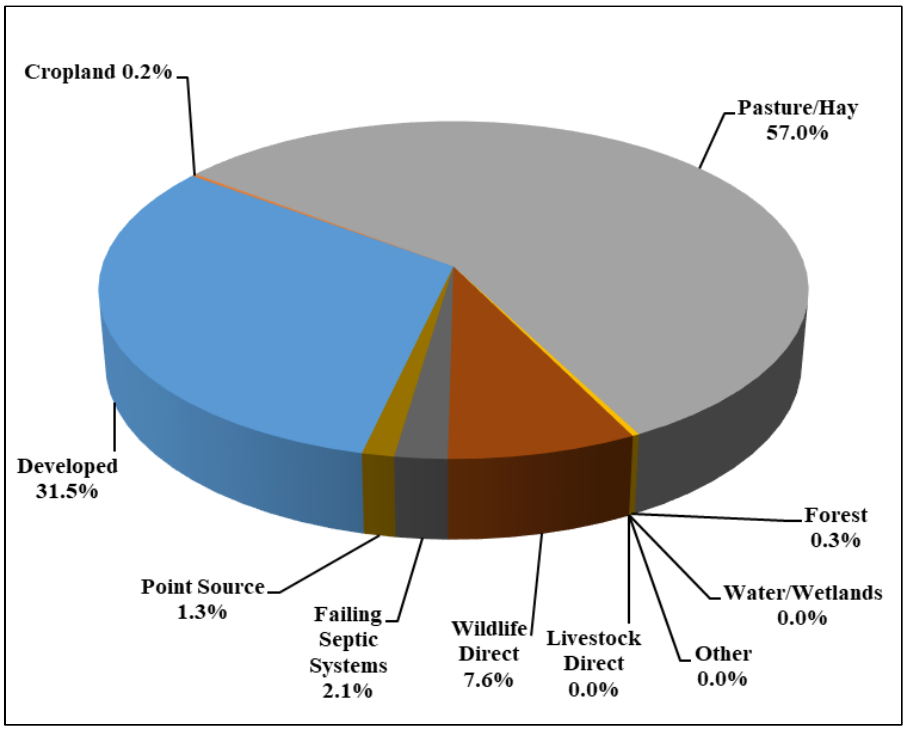

Figure 3-6. Bacteria Sources in Big Toby Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Big Toby Creek subwatershed (Table 3-8).

Table 3-6. Big Toby Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	9.18E+12	4.62E+11	95%
Cropland	6.20E+10	3.10E+09	95%
Pasture/Hay	1.66E+13	8.31E+11	95%
Forest	8.05E+10	8.05E+10	0%
Livestock Direct	2.54E+08	0.00E+00	100%
Wildlife Direct	2.21E+12	1.27E+12	43%
Failing Septic Systems	6.13E+11	0.00E+00	100%
Point Source	3.76E+11	5.15E+09	0%
Total	**2.91E+13**	**2.65E+12**	**91%**

3.2.4 Birch Creek, Unnamed Tributary (Nested)

Description of Watershed and Impairment

Birch Creek, Unnamed Tributary is located in western Halifax County (Figure 3-7). The creek flows south until its confluence with the impaired Birch Creek. The drainage area of this subwatershed is approximately 4,754 acres. The dominant land uses (NCLD 2011) consist of forest (60%) and pasture/hay (79%). Most of the pasture/hay land occurs in the north and south of the watershed.

Birch Creek, Unnamed Tributary was first listed as impaired in VADEQ's 2006 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of Virginia's water quality standard for *E. coli*. Specifically, four out of 11 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 5.35 miles of the waterbody (Table 3-9).

Table 3-7. Impairment Summary for Birch Creek, Unnamed Tributary

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L63R_XDK01A06	5.35[1]	From its headwaters to the mouth on Birch Creek	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

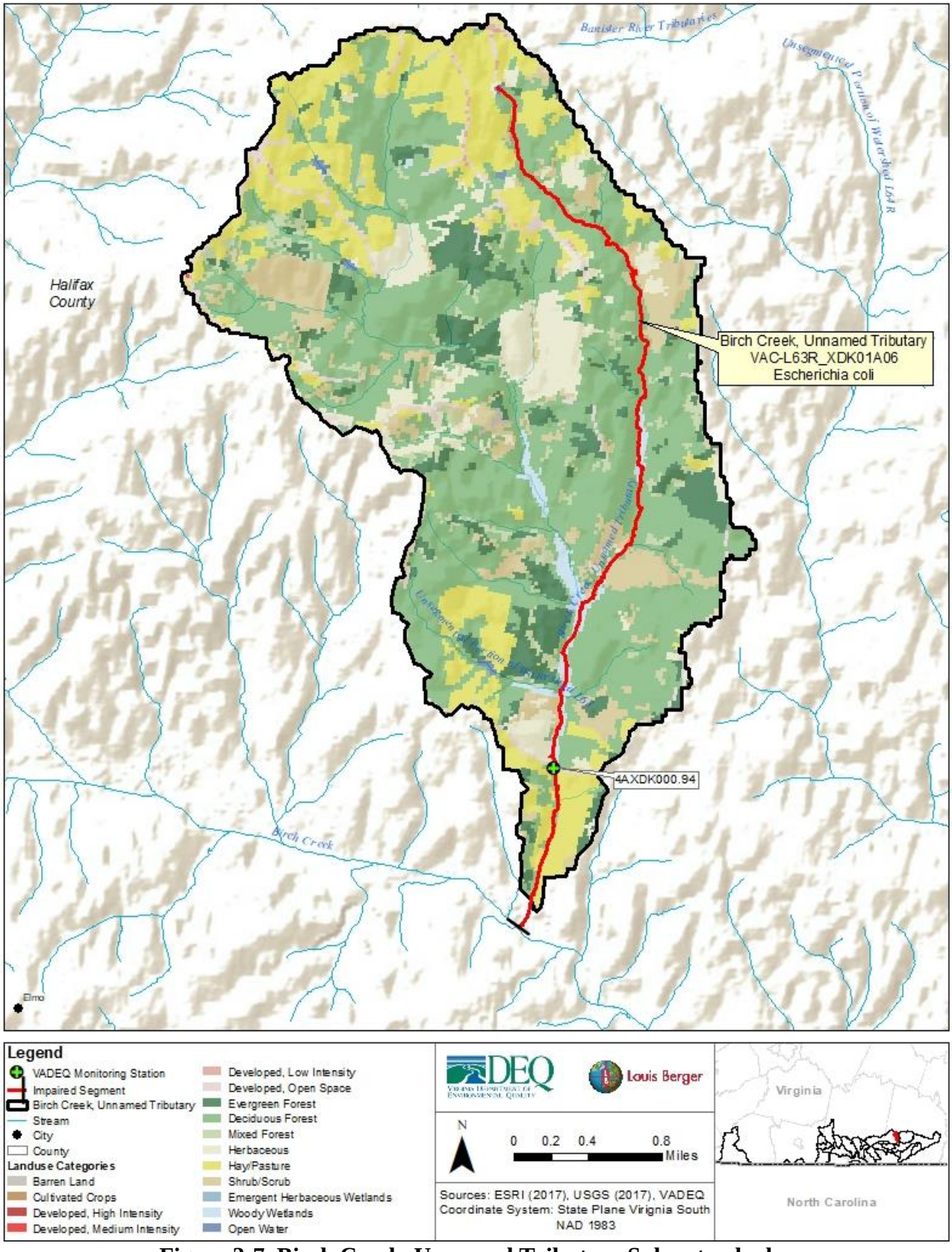

Figure 3-7. Birch Creek, Unnamed Tributary Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Birch Creek, Unnamed Tributary subwatershed is nonpoint source runoff from developed land use (Figure 3-8).

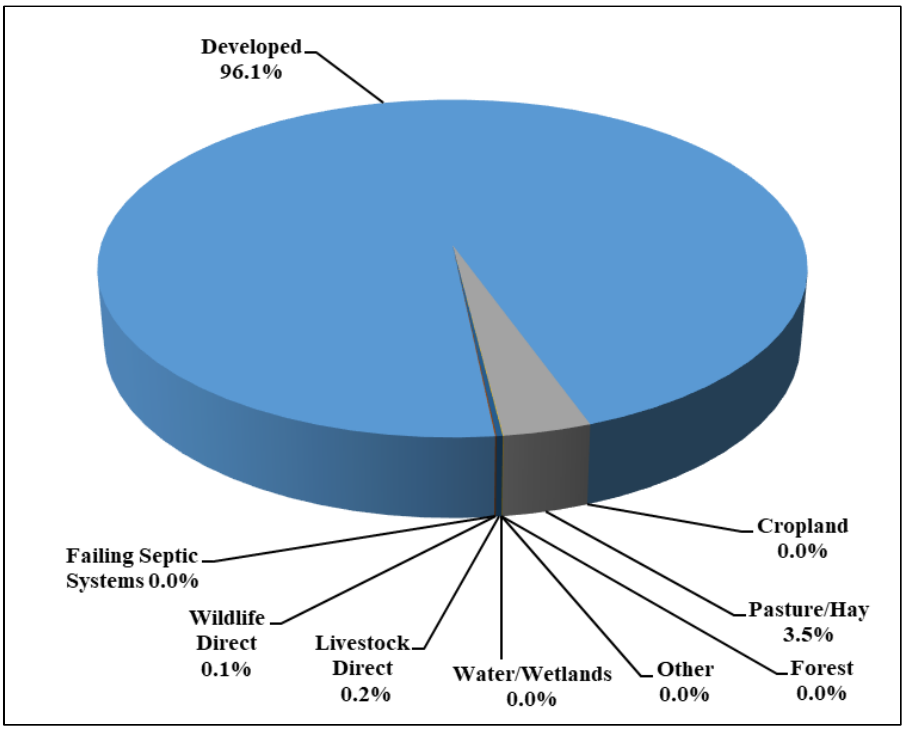

Figure 3-8. Bacteria Sources in Birch Creek, Unnamed Tributary Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Birch Creek, Unnamed Tributary subwatershed (Table 3-10).

Table 3-8. Birch Creek, Unnamed Tributary Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	4.56E+14	1.37E+13	97%
Cropland	7.52E+08	2.25E+07	97%
Pasture/Hay	1.68E+13	5.03E+11	97%
Forest	1.17E+11	1.17E+11	0%
Livestock Direct	1.16E+12	0.00E+00	100%
Wildlife Direct	2.56E+11	8.69E+10	66%
Failing Septic Systems	8.07E+08	0.00E+00	100%
Total	**4.74E+14**	**1.44E+13**	**97%**

3.2.5 Byrds Branch

Description of Watershed and Impairment

Byrds Branch is located in southwestern Halifax County (Figure 3-9). The creek flows from its headwaters southeast to its confluence with the Dan River. The subwatershed has a drainage area of approximately 1,812 acres. The dominant land uses (2011 NLCD) are forest (59%) and pasture/hay (21%).

Segments of Byrds Branch were first listed as impaired in VADEQ's 2004 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the fecal coliform bacteria water quality standard (400 cfu/100 ml instantaneous criterion). After the initial listing, an *E. coli* standard was established, and subsequent listings were based on exceedances of the *E. coli* single sample maximum of 235 cfu/100 ml. Two monitoring stations showed exceedances of the 235 cfu/100 ml *E. coli* single sample maximum. The two separate stations showed that two out of six samples exceeded the *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 3.76 miles of the waterbody (Table 3-11).

Table 3-9. Impairment Summary for Byrds Branch

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L62R_BYR01A04	3.76	Byrds Branch from its headwaters to the mouth at the Dan River	*Escherichia coli*

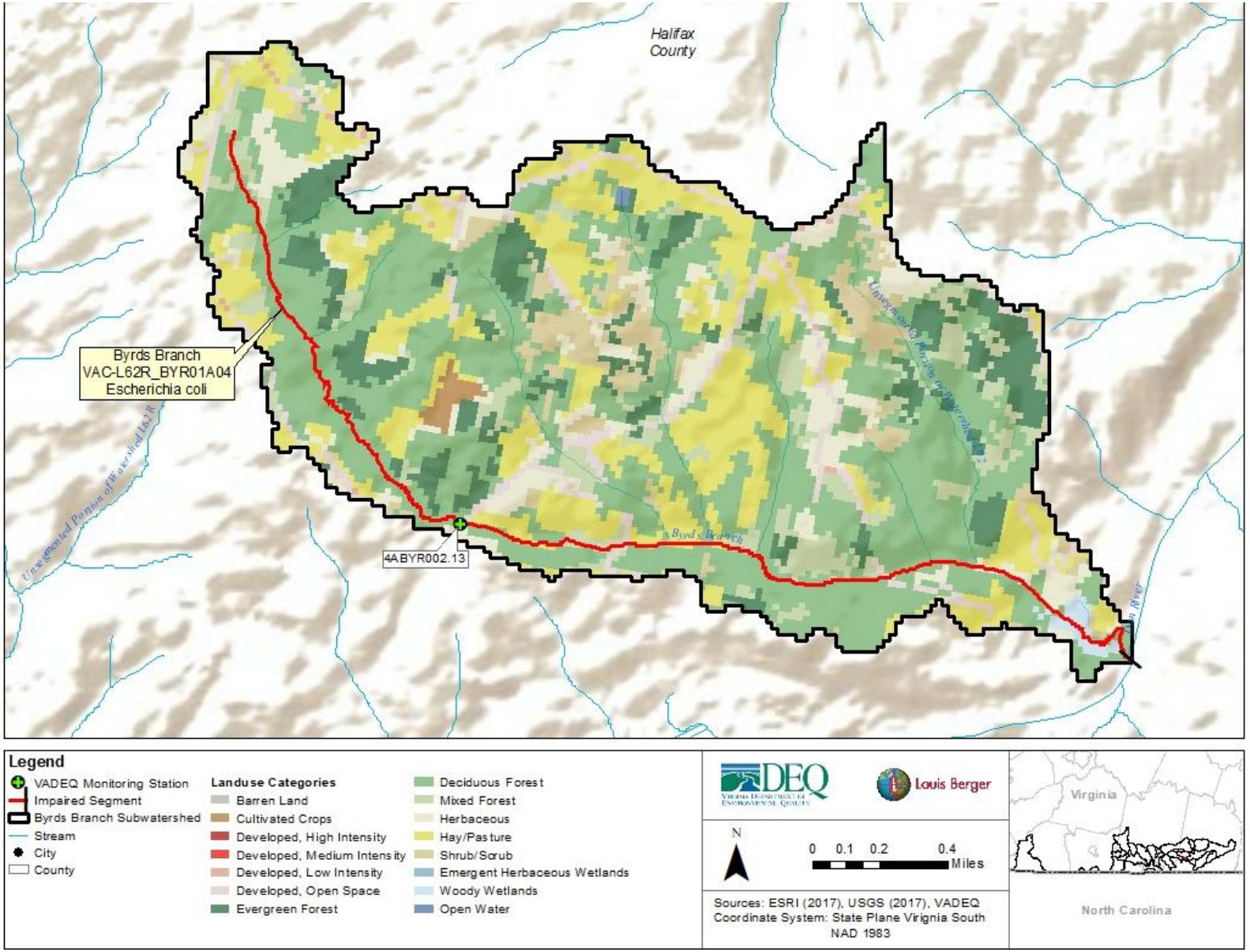

Figure 3-9. Byrds Branch Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Byrds Branch subwatershed is nonpoint source runoff from pasture/hay land use and wildlife direct sources (Figure 3-10).

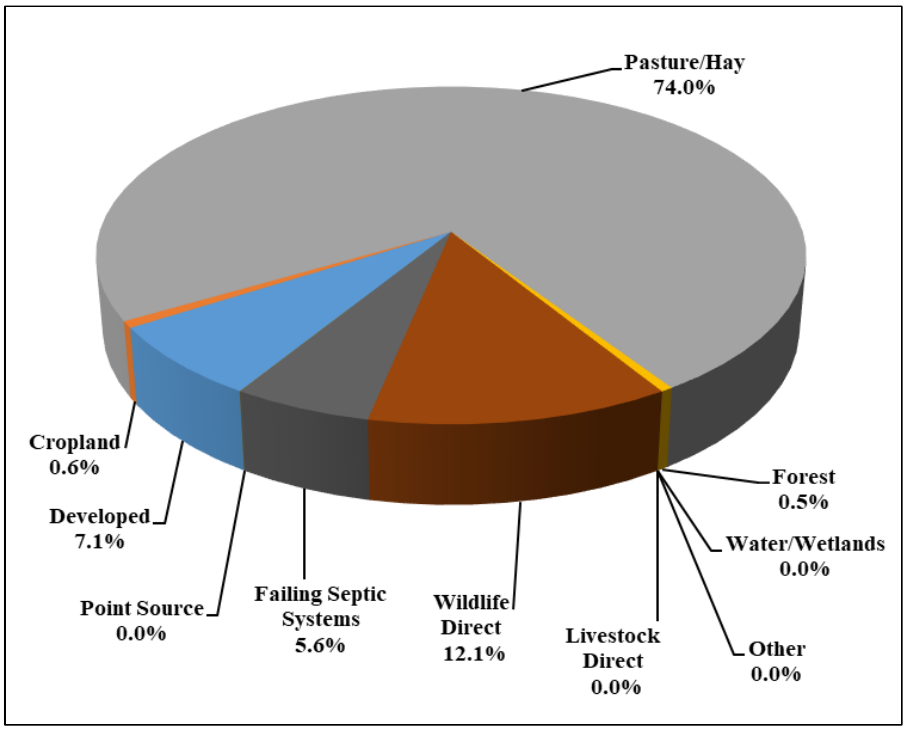

Figure 3-10. Bacteria Sources in Byrds Branch Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Byrds Branch subwatershed (Table 3-12).

Table 3-10. Byrds Branch Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	4.68E+11	2.34E+10	95%
Cropland	4.28E+10	2.14E+09	95%
Pasture/Hay	4.88E+12	2.44E+11	95%
Forest	3.25E+10	3.25E+10	0%
Livestock Direct	6.24E+06	0.00E+00	100%
Wildlife Direct	8.01E+11	5.46E+11	39%
Failing Septic Systems	3.69E+11	0.00E+00	100%
Point Source	1.04E+09	1.43E+07	0%
Total	**6.60E+12**	**8.48E+11**	**87%**

3.2.6 Cane Creek (Nested)

Description of Watershed and Impairment

Most of the Cane Creek subwatershed is located in Pittsylvania County with a small portion within the City of Danville boundary (Figure 3-11). The headwaters of the creek flow from Pittsylvania County south and east through the City of Danville before flowing across the Virginia-North Carolina state line. The subwatershed drains approximately 13,186 acres. The dominant land uses (2011 NLCD) are forest (43%) and pasture/hay (26%). Small portions of herbaceous lands (11%) are also located throughout the watershed.

Cane Creek was first listed as impaired in VADEQ's 2008 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, three out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 12.26 miles of the waterbody (Table 3-13).

Table 3-11. Impairment Summary for Cane Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L60R_CAN1A02	12.26[1]	Cane Creek mainstem from its headwaters downstream to the VA/NC State Line.	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

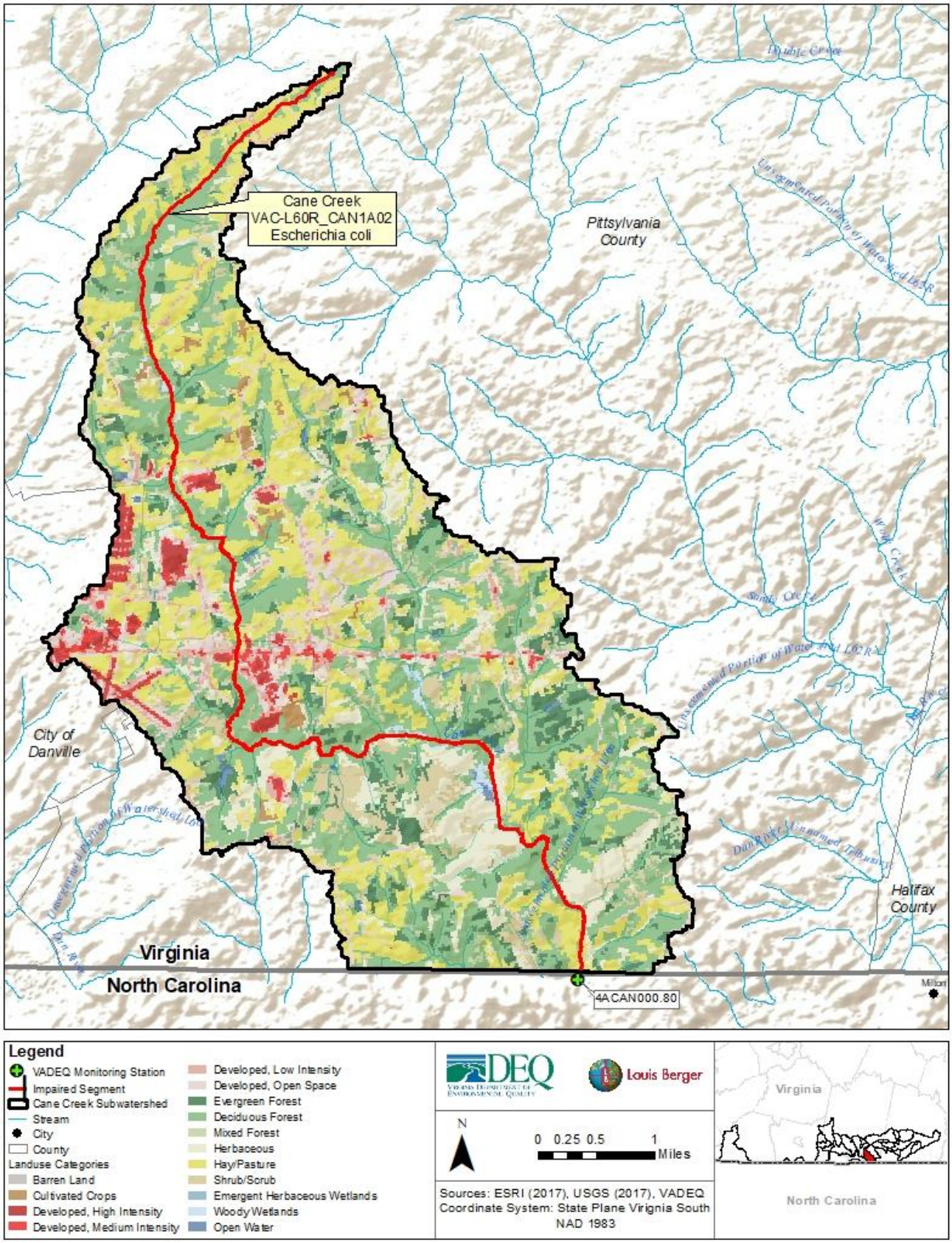

Figure 3-11. Cane Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Cane Creek subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-12).

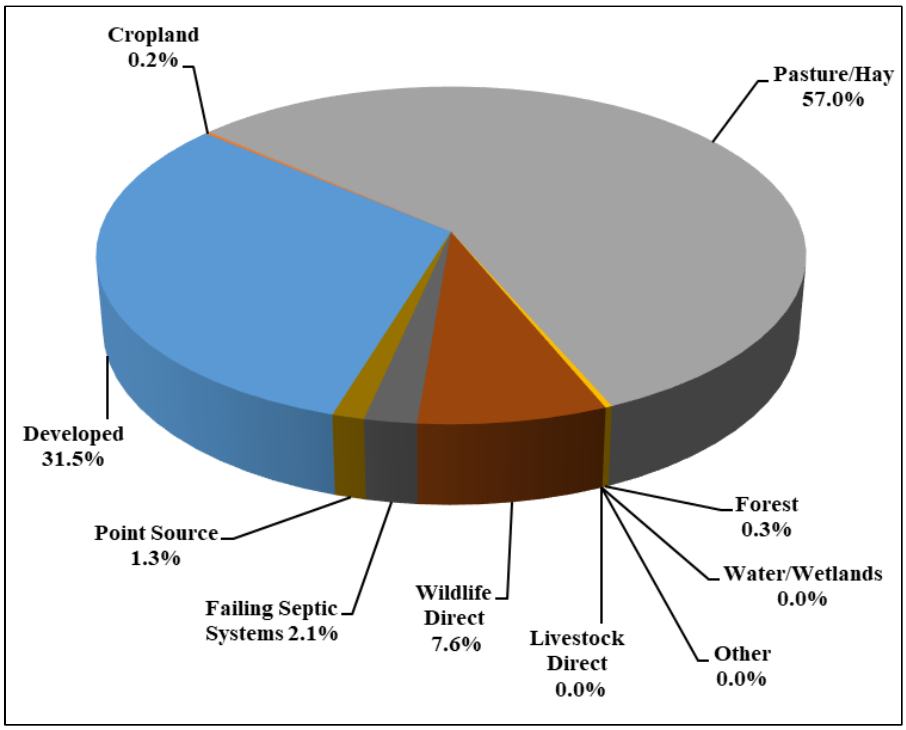

Figure 3-12. Bacteria Sources in Cane Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Cane Creek subwatershed (Table 3-14).

Table 3-12. Cane Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	1.58E+13	7.93E+11	95%
Cropland	1.06E+11	5.32E+09	95%
Pasture/Hay	2.85E+13	1.43E+12	95%
Forest	1.38E+11	1.38E+11	0%
Livestock Direct	4.36E+08	0.00E+00	100%
Wildlife Direct	3.79E+12	2.18E+12	43%
Failing Septic Systems	1.05E+12	0.00E+00	100%
Point Source	6.45E+11	8.84E+09	0%
Total	**5.00E+13**	**4.55E+12**	**91%**

3.2.7 Cascade Creek (Nested)

Description of Watershed and Impairment

The headwaters of Cascade Creek are located in eastern Henry County (Figure 3-13). The creek flows southeast into Pittsylvania County before flowing across the Virginia-North Carolina state line. The subwatershed drains approximately 20,919 acres. The dominant land uses (2011 NLCD) are forest (59%) and pasture/hay (19%). Small portions of herbaceous lands (13%) are also located throughout the watershed.

Cascade Creek was first listed as impaired in VADEQ's 2006 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of Virginia's water quality standard for *E. coli*. Specifically, four out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 11.97 miles of the waterbody (Table 3-15).

Table 3-13. Impairment Summary for Cascade Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L57R_CAS01A00	11.79[1]	Cascade Creek mainstem from the VA/NC State Line upstream to its headwaters.	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

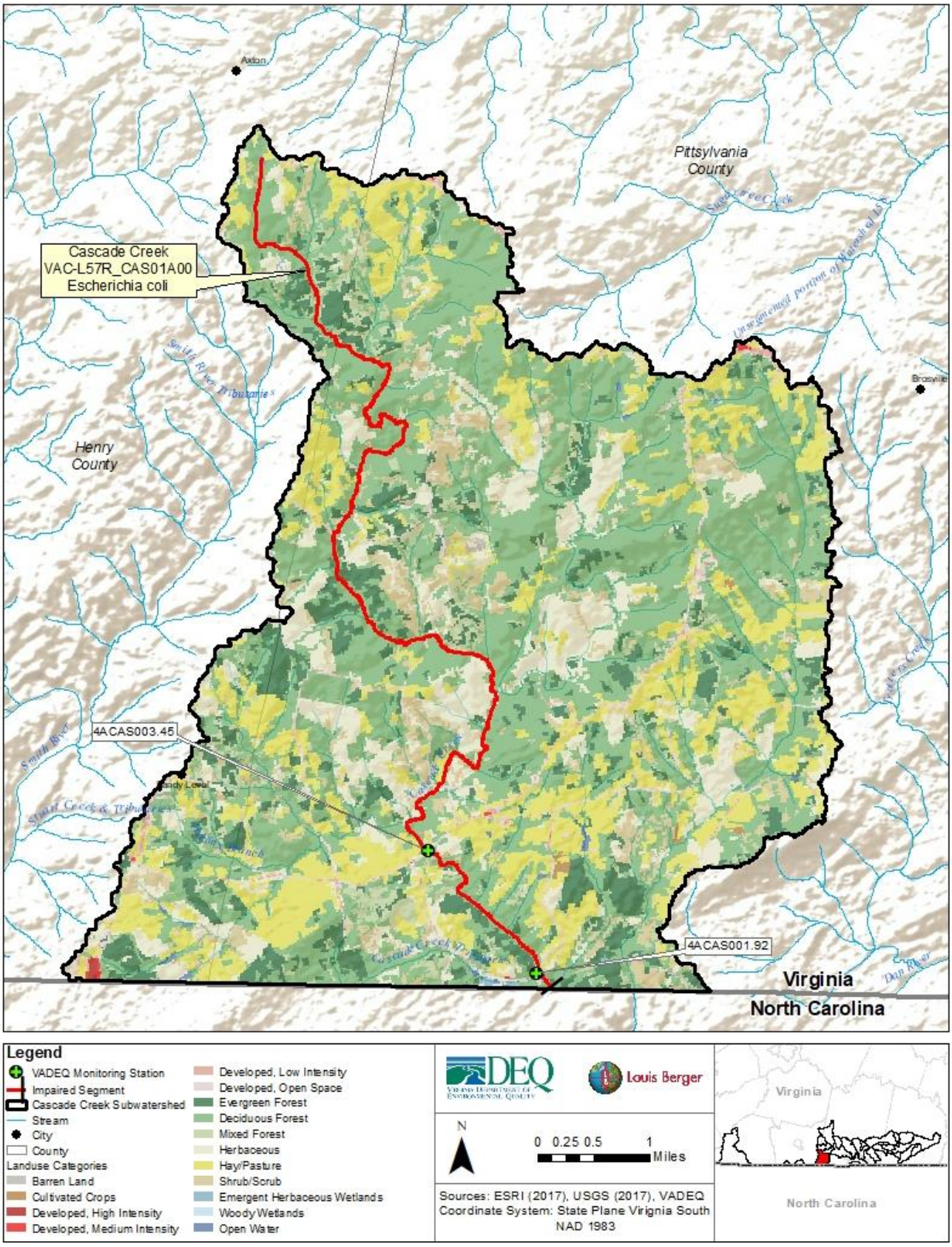

Figure 3-13. Cascade Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Cascade Creek subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-14).

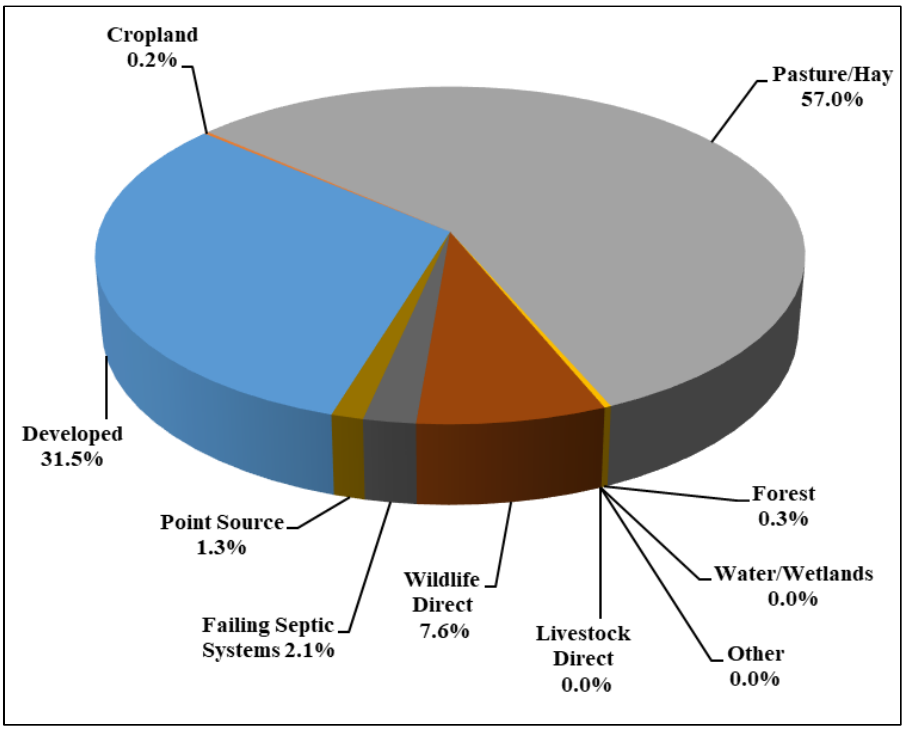

Figure 3-14. Bacteria Sources in Cascade Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Cascade Creek subwatershed (Table 3-16).

Table 3-14. Cascade Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.50E+13	1.26E+12	95%
Cropland	1.69E+11	8.45E+09	95%
Pasture/Hay	4.53E+13	2.26E+12	95%
Forest	2.19E+11	2.19E+11	0%
Livestock Direct	6.91E+08	0.00E+00	100%
Wildlife Direct	6.01E+12	3.45E+12	43%
Failing Septic Systems	1.67E+12	0.00E+00	100%
Point Source	1.02E+12	1.40E+10	0%
Total	**7.94E+13**	**7.21E+12**	**91%**

3.2.8 Double Creek

Description of Watershed and Impairment

Double Creek is located in Pittsylvania and Halifax Counties (Figure 3-15). The headwaters of the creek are in eastern Pittsylvania County and the creek flows southeast into Halifax County until its confluence with the Dan River. The subwatershed has a drainage area of approximately 9,212 acres. The dominant land uses (2011 NLCD) are forest (56%) and pasture/hay (18%) with a scattering of herbaceous lands (14%).

Double Creek was first listed as impaired in VADEQ's 2002 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the fecal coliform bacteria water quality standard (400 cfu/100 ml instantaneous criterion). After the initial listing, an *E. coli* standard was established, and subsequent listings were based on exceedances of the *E. coli* single sample maximum of 235 cfu/100 ml. A monitoring station showed two out of 12 samples exceeded the *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 8.89 miles of the waterbody (Table 3-17).

Table 3-15. Impairment Summary for Double Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L62R_DBC01A98	8.89	Headwaters to Dan River	*Escherichia coli*

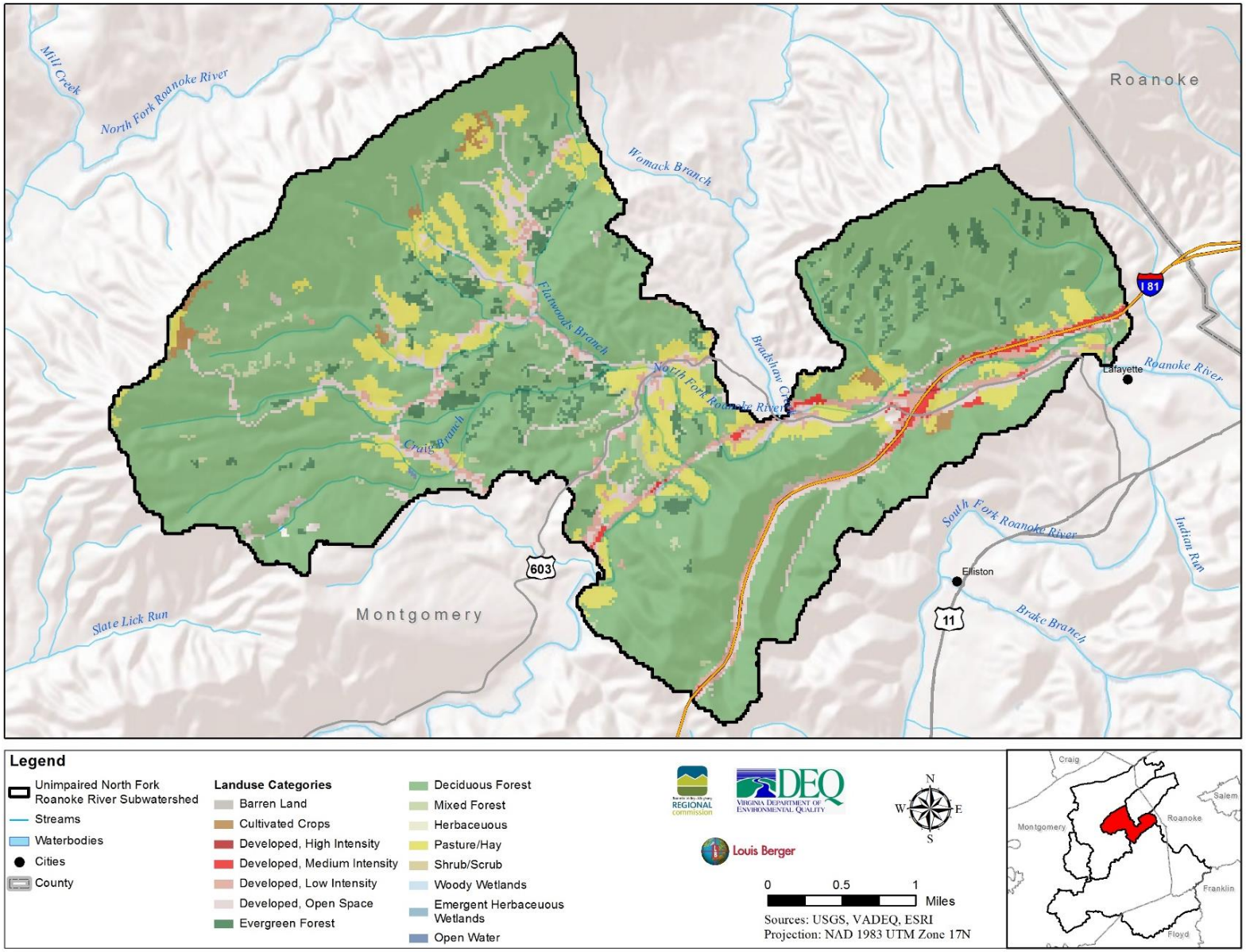

Figure 3-15. Double Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Double Creek subwatershed is nonpoint source runoff from pasture/hay land use (Figure 3-16).

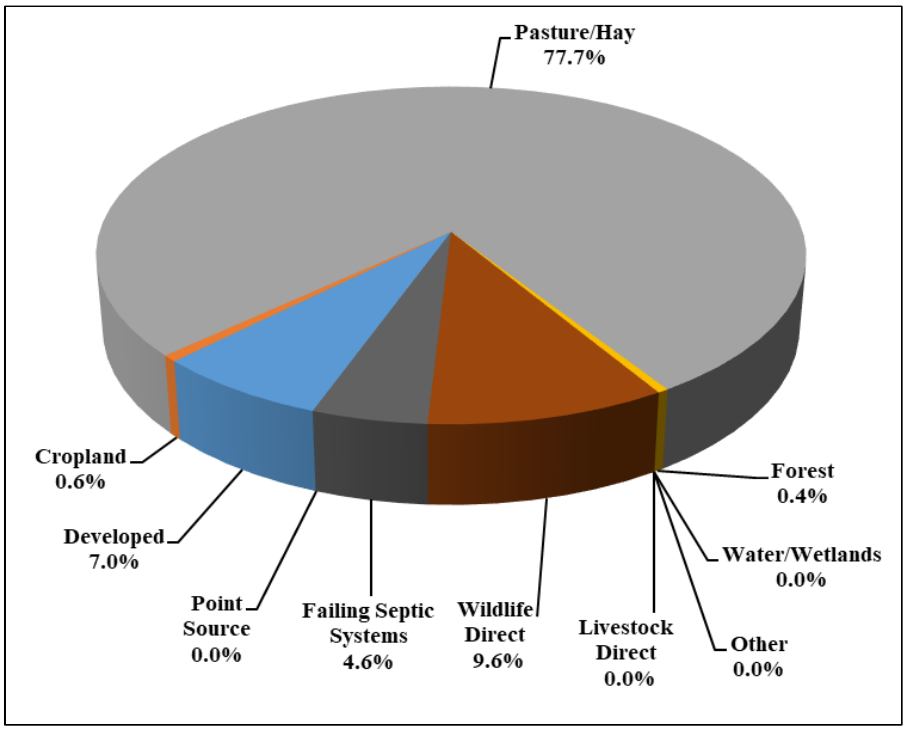

Figure 3-16. Bacteria Sources in Double Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Double Creek subwatershed (Table 3-18).

Table 3-16. Double Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.58E+12	3.61E+11	86%
Cropland	2.27E+11	3.18E+10	86%
Pasture/Hay	2.87E+13	4.02E+12	86%
Forest	1.60E+11	1.60E+11	0%
Livestock Direct	5.13E+07	0.00E+00	100%
Wildlife Direct	3.55E+12	4.57E+12	0%
Failing Septic Systems	1.71E+12	0.00E+00	100%
Point Source	0.00E+00	2.07E+08	0%
Total	**3.69E+13**	**9.14E+12**	**75%**

3.2.9 Fall Creek

Description of Watershed and Impairment

Fall Creek is located in southcentral Pittsylvania County and northern Danville (Figure 3-17). The creek flows south until its confluence with the Dan River in the City of Danville. The drainage area of this subwatershed is approximately 19,998 acres. The dominant NLCD 2011 land uses consist of forest (46%), developed land (21%), and pasture/hay (19%). The developed land associated with the City of Danville is located in the southern and western portions of the watershed.

Segments of Fall Creek were first listed as impaired in VADEQ's 2004 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the fecal coliform bacteria water quality standard (400 cfu/100 ml instantaneous criterion). After the initial listing, an *E. coli* standard was established, and subsequent listings were based on exceedances of the *E. coli* single sample maximum of 235 cfu/100 ml. Two monitoring stations showed exceedances of the 235 cfu/100 ml *E. coli* single sample maximum. The stations showed three out of 12 samples and five out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 11.97 miles of the waterbody (Table 3-19).

Table 3-17. Impairment Summary for Fall Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L61R_FAL01A00	11.97	Fall Creek mainstem from its mouth on the Dan River upstream to its headwaters.	*Escherichia coli*

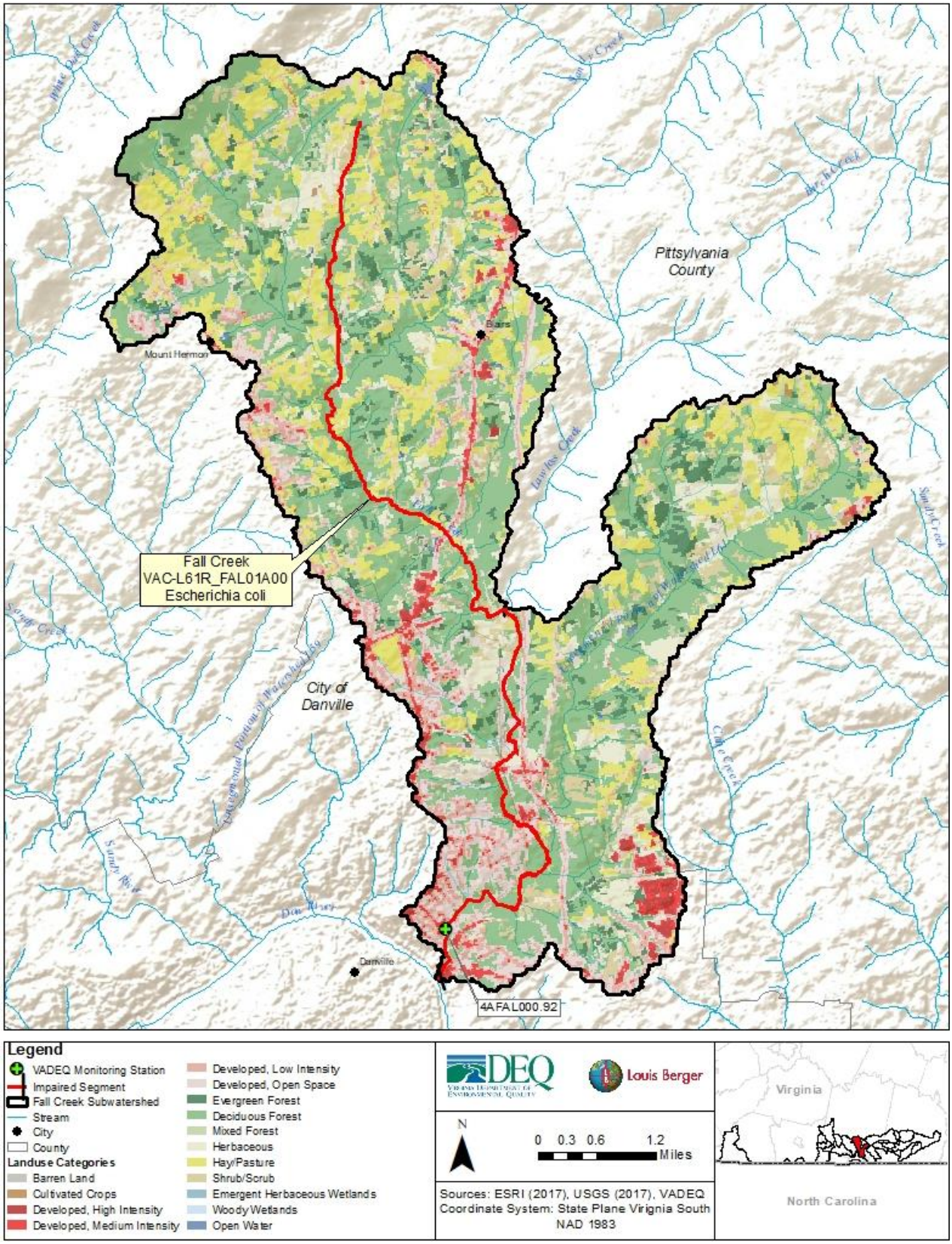

Figure 3-17. Fall Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Fall Creek subwatershed is nonpoint source runoff from developed and pasture/hay land uses (Figure 3-18).

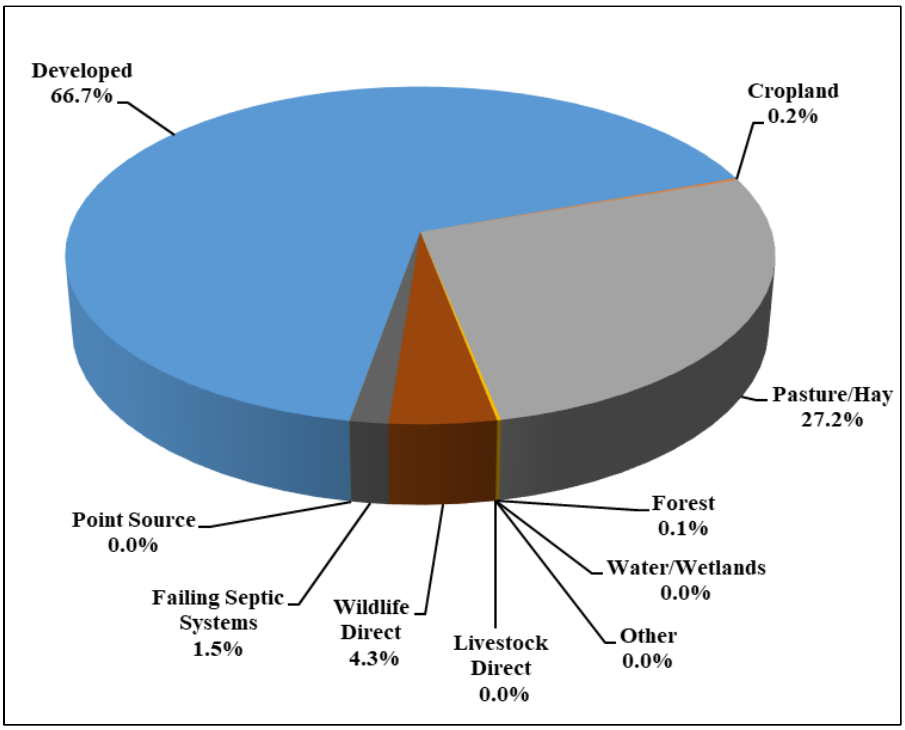

Figure 3-18. Bacteria Sources in Fall Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Fall Creek subwatershed (Table 3-20).

Table 3-18. Fall Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	1.19E+14	3.57E+12	97%
Cropland	3.04E+11	9.13E+09	97%
Pasture/Hay	4.84E+13	1.45E+12	97%
Forest	2.64E+11	2.64E+11	0%
Livestock Direct	7.48E+09	0.00E+00	100%
Wildlife Direct	7.59E+12	8.75E+12	0%
Failing Septic Systems	2.72E+12	0.00E+00	100%
Point Source	1.66E+10	2.27E+08	0%
Total	**1.78E+14**	**1.40E+13**	**92%**

3.2.10 Germy Creek (Nested)

Description of Watershed and Impairment

The headwaters of Germy Creek are located in eastern Pittsylvania County (Figure 3-19). From Pittsylvania County, the creek flows east into Halifax County before its confluence with the impaired Birch Creek. The drainage area of this subwatershed is approximately 2,891 acres. The dominant NLCD 2011 land uses consist of forest (59%) and pasture/hay land (23%).

Germy Creek was first listed as impaired in VADEQ's 2014 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of Virginia's water quality standard for *E. coli*. Specifically, five out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 5.37 miles of the waterbody (Table 3-21).

Table 3-19. Impairment Summary for Germy Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L63R_GER01A08	5.37[1]	Germy Creek from its headwaters to its mouth on Birch Creek	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

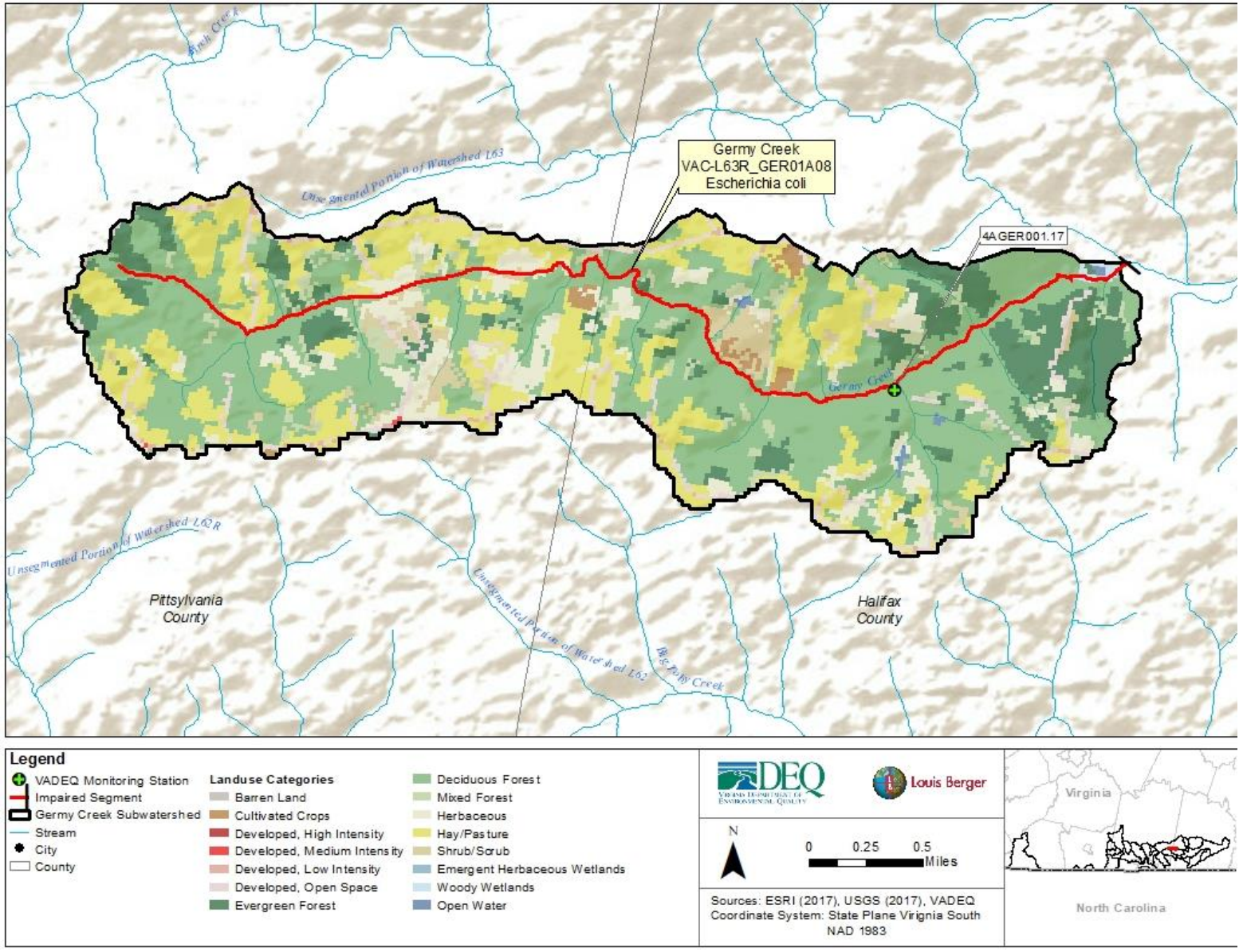

Figure 3-19. Germy Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Germy Creek subwatershed is nonpoint source runoff from developed land use (Figure 3-20).

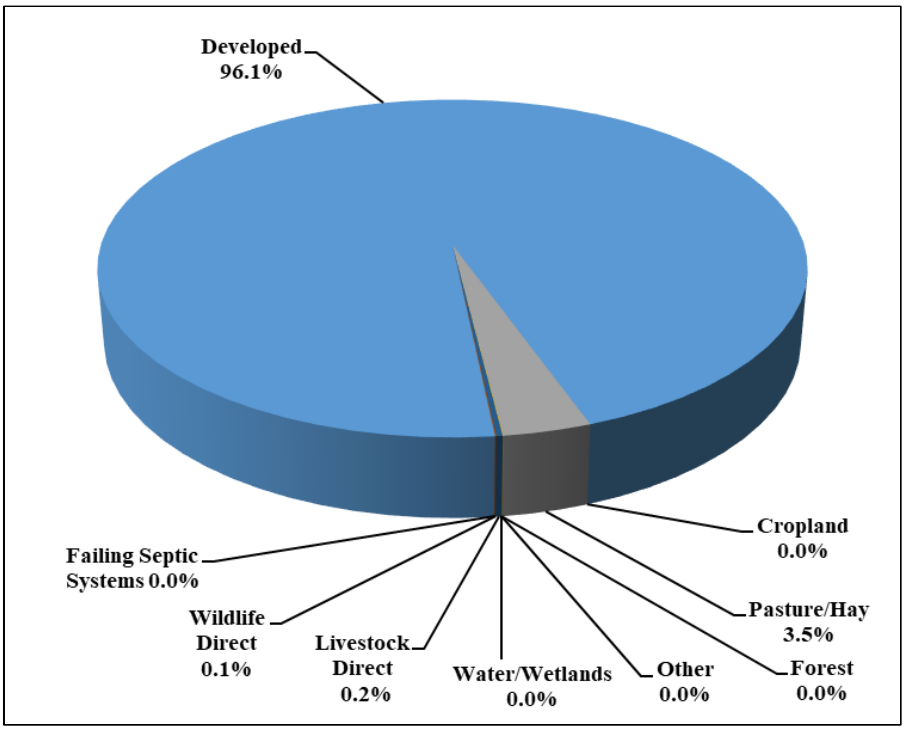

Figure 3-20. Bacteria Sources in Germy Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Germy Creek subwatershed (Table 3-22).

Table 3-20. Germy Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.77E+14	8.32E+12	97%
Cropland	4.57E+08	1.37E+07	97%
Pasture/Hay	1.02E+13	3.06E+11	97%
Forest	7.12E+10	7.12E+10	0%
Livestock Direct	7.05E+11	0.00E+00	100%
Wildlife Direct	1.56E+11	5.29E+10	66%
Failing Septic Systems	4.91E+08	0.00E+00	100%
Total	**2.88E+14**	**8.75E+12**	**97%**

3.2.11 Lawless Creek (Nested)

Description of Watershed and Impairment

Lawless Creek is located in southcentral Pittsylvania County north of the City of Danville (Figure 3-21). The creek flows west then south until its confluence with the impaired Fall Creek. The subwatershed has a drainage area of approximately 3,898 acres. The dominant land uses (2011 NLCD) are forest (49%) and pasture/hay (24%) with a scattering of developed lands (10%).

Lawless Creek was first listed as impaired in VADEQ's 2014 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, two out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 4.72 miles of the waterbody (Table 3-23).

Table 3-21. Impairment Summary for Lawless Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L61R_LAW01A04	4.72[1]	Lawless Creek from its headwaters to its mouth at Fall Creek.	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

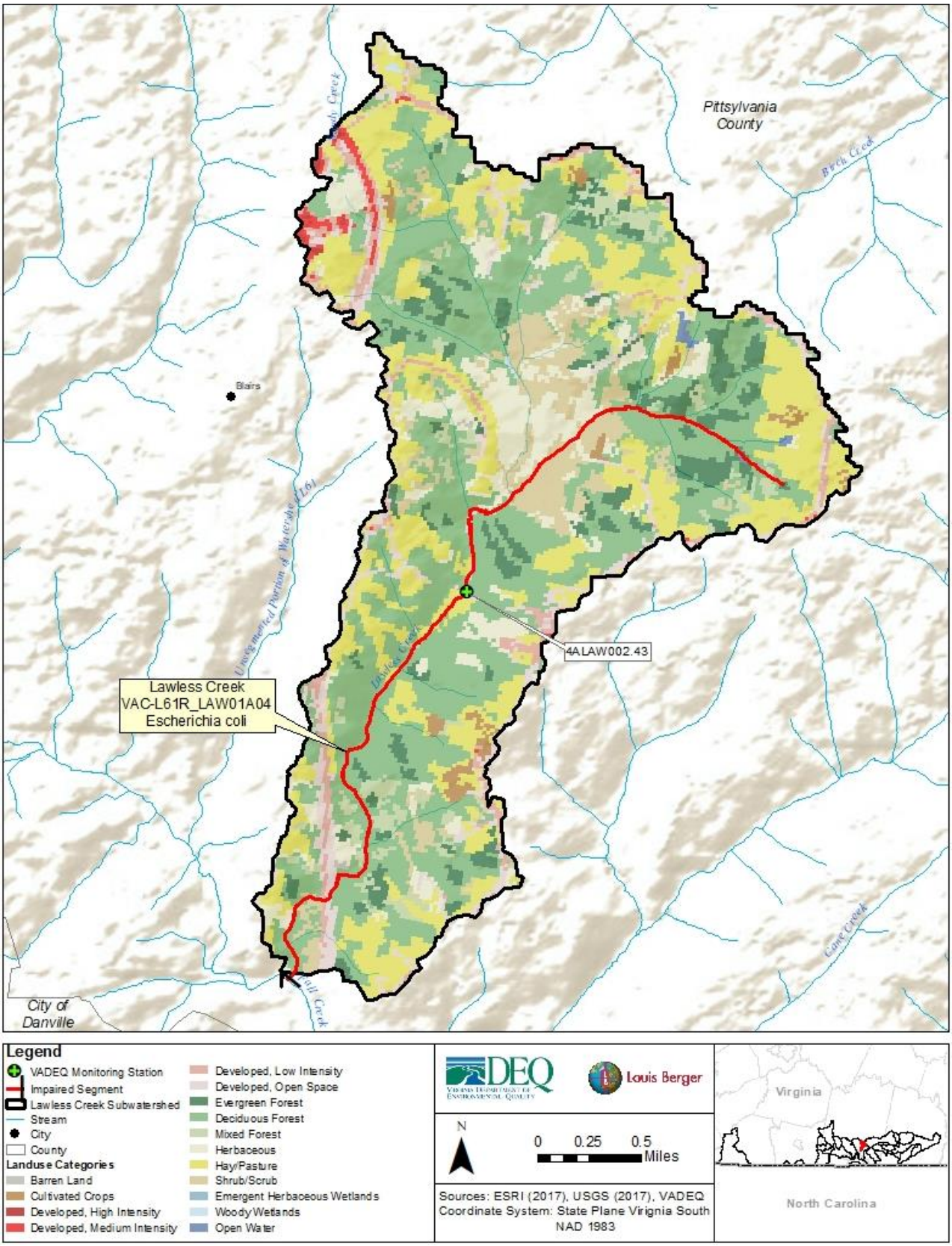

Figure 3-21. Lawless Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Lawless Creek subwatershed is nonpoint source runoff from developed and pasture/hay land uses (Figure 3-22).

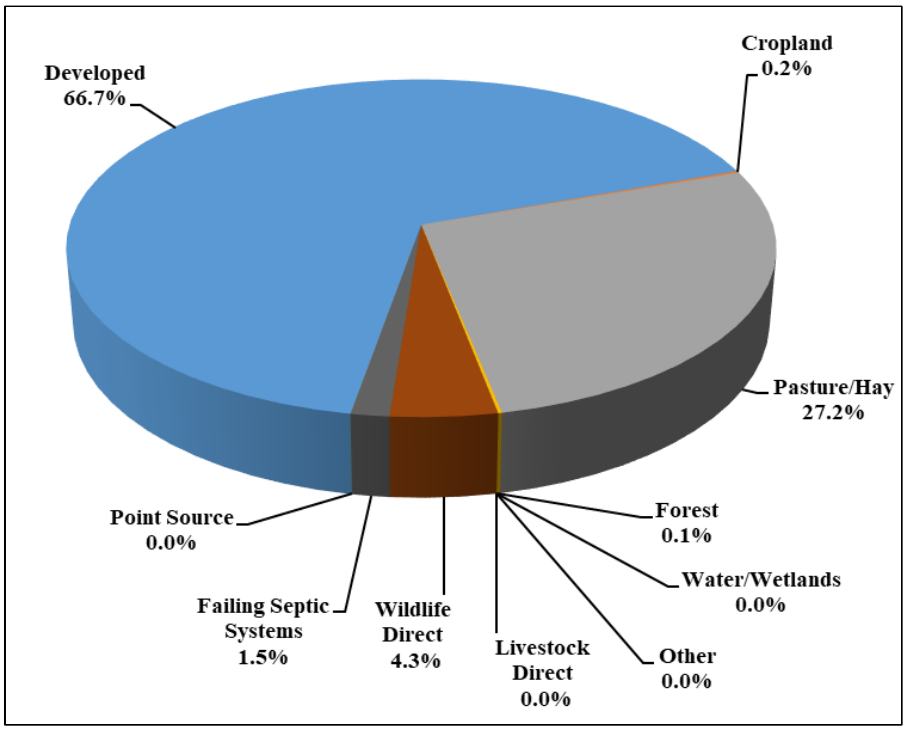

Figure 3-22. Bacteria Sources in Lawless Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Lawless Creek subwatershed (Table 3-24).

Table 3-22. Lawless Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.32E+13	6.95E+11	97%
Cropland	5.93E+10	1.78E+09	97%
Pasture/Hay	9.44E+12	2.83E+11	97%
Forest	5.15E+10	5.15E+10	0%
Livestock Direct	1.46E+09	0.00E+00	100%
Wildlife Direct	1.48E+12	1.71E+12	0%
Failing Septic Systems	5.30E+11	0.00E+00	100%
Point Source	3.24E+09	4.43E+07	0%
Total	**3.47E+13**	**2.74E+12**	**92%**

3.2.12 Lawsons Creek (Nested)

Description of Watershed and Impairment

The headwaters of Lawsons Creek are located in southcentral Halifax County (Figure 3-23). The creek flows northeast until its confluence with the Dan River west of Riverdale, Virginia. The drainage area of this subwatershed is approximately 16,879 acres. The dominant NLCD 2011 land uses consist of forest (43%), pasture/hay (26%), and herbaceous land (11%).

The two segments of Lawsons Creek were first listed as impaired in VADEQ's 2008 or 2012 305(b)/303(d) Water Quality Assessment Integrated Reports due to exceedances of the *E. coli* water quality standard. Specifically, three out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 15.54 miles of the waterbody (Table 3-25).

Table 3-23: Impairment Summary for Lawsons Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L64R_LSN01A98	8.27[1]	Headwaters to Jerimy Creek	*Escherichia coli*
VAC-L64R_LSN02A02	7.27[1]	Jerimy Creek to Dan River	

[1]Segments were nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

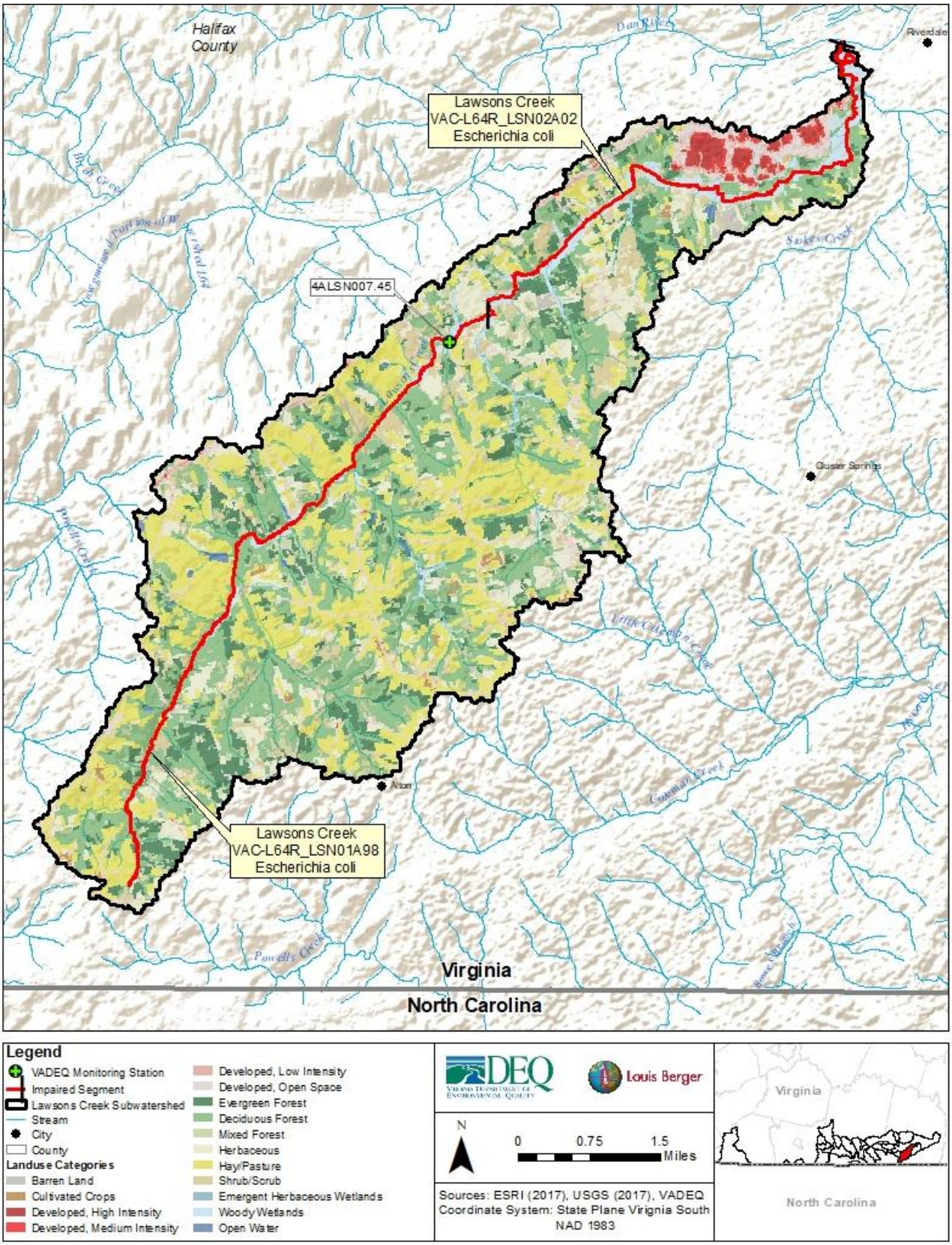

Figure 3-23. Lawsons Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Lawsons Creek subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-24).

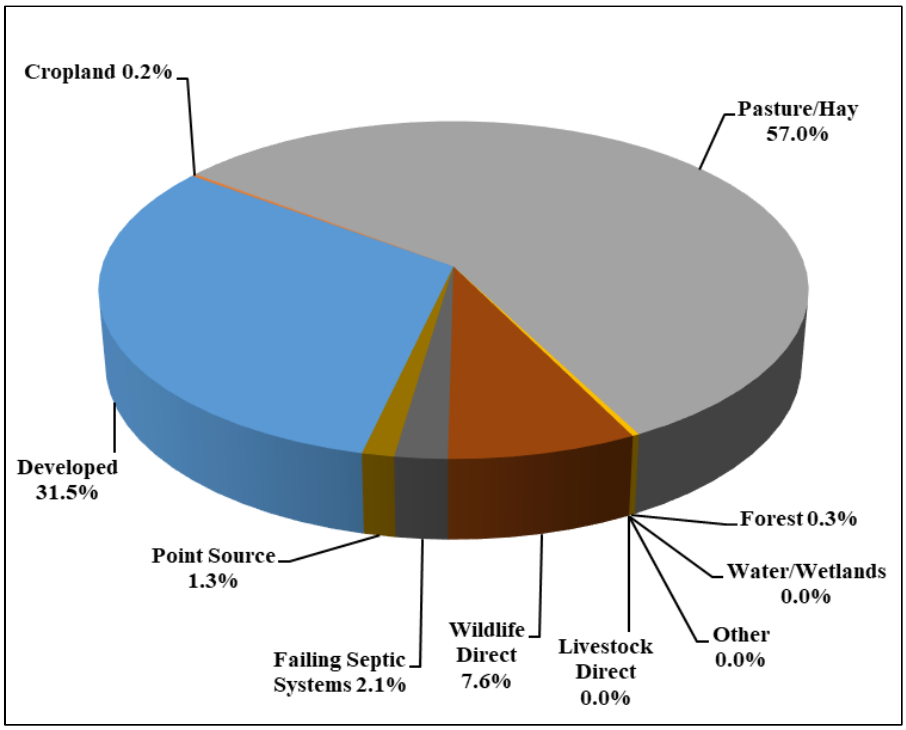

Figure 3-24. Bacteria Sources in Lawsons Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Lawsons Creek subwatershed (Table 3-26).

Table 3-24. Lawsons Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.02E+13	1.01E+12	95%
Cropland	1.36E+11	6.81E+09	95%
Pasture/Hay	3.65E+13	1.83E+12	95%
Forest	1.77E+11	1.77E+11	0%
Livestock Direct	5.58E+08	0.00E+00	100%
Wildlife Direct	4.85E+12	2.78E+12	43%
Failing Septic Systems	1.35E+12	0.00E+00	100%
Point Source	8.26E+11	1.13E+10	0%
Total	**6.41E+13**	**5.82E+12**	**91%**

3.2.13 Miry Creek (Nested)

Description of Watershed and Impairment

Miry Creek is located in central Halifax County and flows south until its confluence with the Dan River. (Figure 3-25). The subwatershed has a drainage area of approximately 18,731 acres. The dominant NLCD 2011 land uses consist of forest (54%) and pasture/hay lands (20%).

Miry Creek was first listed as impaired in VADEQ's 2006 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, six out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 1.12 miles of the waterbody (Table 3-27).

Table 3-25. Impairment Summary for Miry Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L64R_MRY01A04	1.12[1]	Miry Creek from the Mikes Creek confluence to the Dan River	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

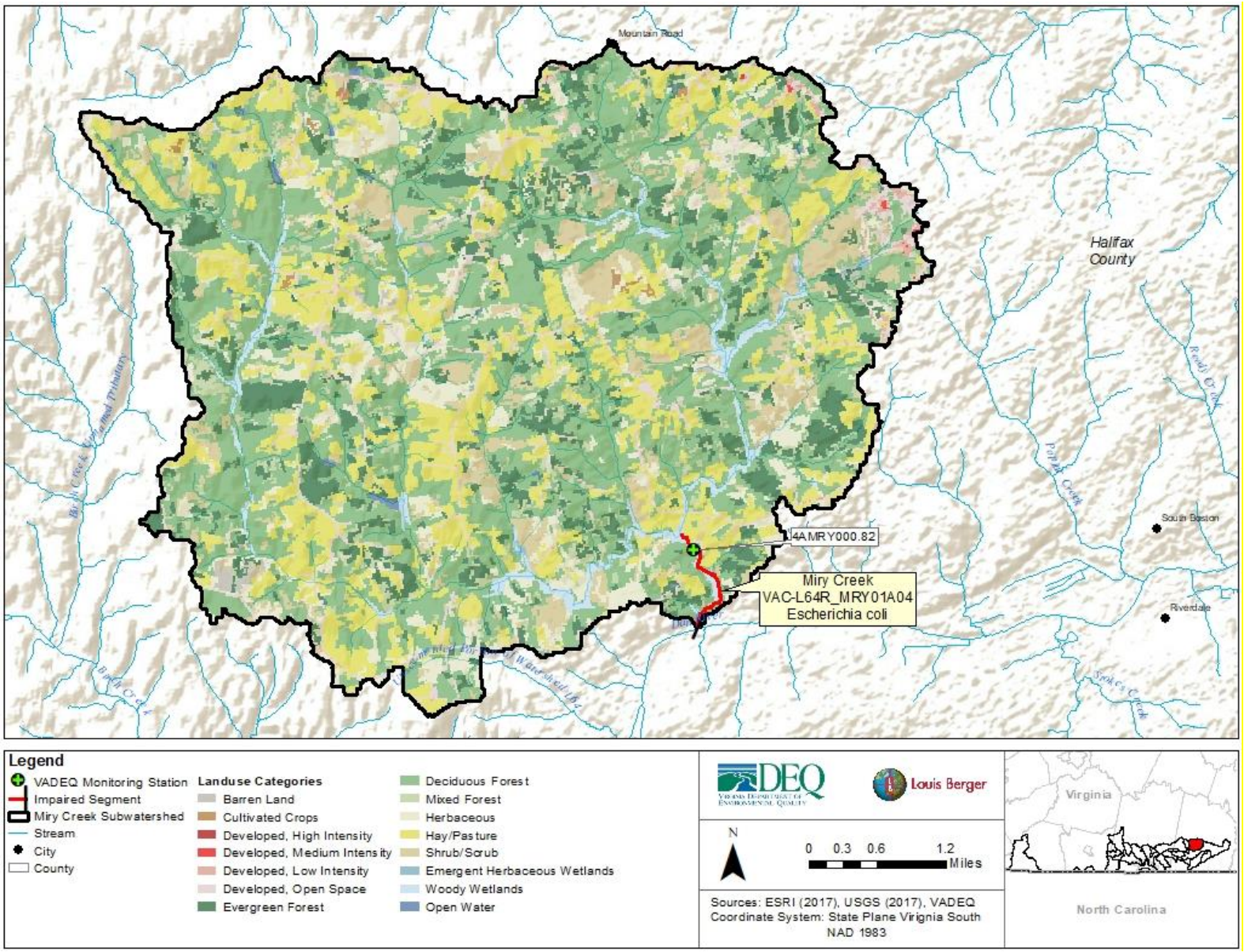

Figure 3-25. Miry Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Miry Creek subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-26).

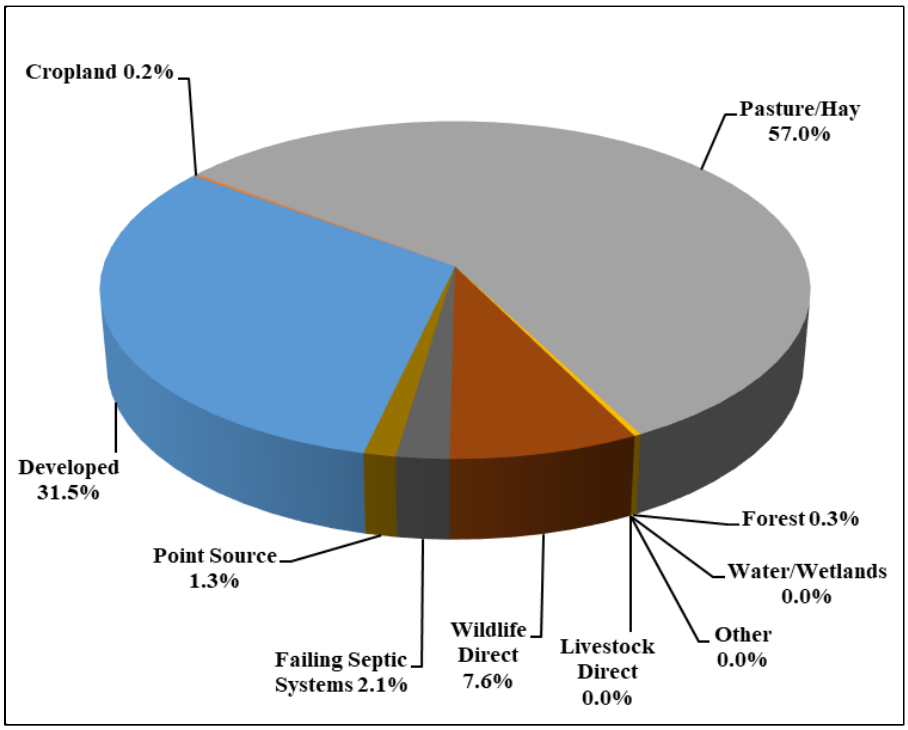

Figure 3-26. Bacteria Sources in Miry Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Miry Creek subwatershed (Table 3-28).

Table 3-26. Miry Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	2.24E+13	1.13E+12	95%
Cropland	1.51E+11	7.56E+09	95%
Pasture/Hay	4.05E+13	2.03E+12	95%
Forest	1.96E+11	1.96E+11	0%
Livestock Direct	6.19E+08	0.00E+00	100%
Wildlife Direct	5.38E+12	3.09E+12	43%
Failing Septic Systems	1.50E+12	0.00E+00	100%
Point Source	9.16E+11	1.26E+10	0%
Total	**7.11E+13**	**6.46E+12**	**91%**

3.2.14 Powells Creek (Nested)

Description of Watershed and Impairment

Powells Creek is located in southwestern Halifax County and flows northwest until its confluence with the Dan River. (Figure 3-27). The drainage area of this subwatershed is approximately 3,838 acres. The dominant NLCD 2011 land uses consist of forest (52%), pasture/hay (23%), and herbaceous lands (11%). The forest is mainly located in the west and south and the pasture/hay in the east.

Powells Creek was first listed as impaired in VADEQ's 2008 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, four out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 4.63 miles of the waterbody (Table 3-29).

Table 3-27. Impairment Summary for Powells Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L62R_POW01A08	4.63[1]	Powells Creek from its headwaters to its mouth on the Dan River	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

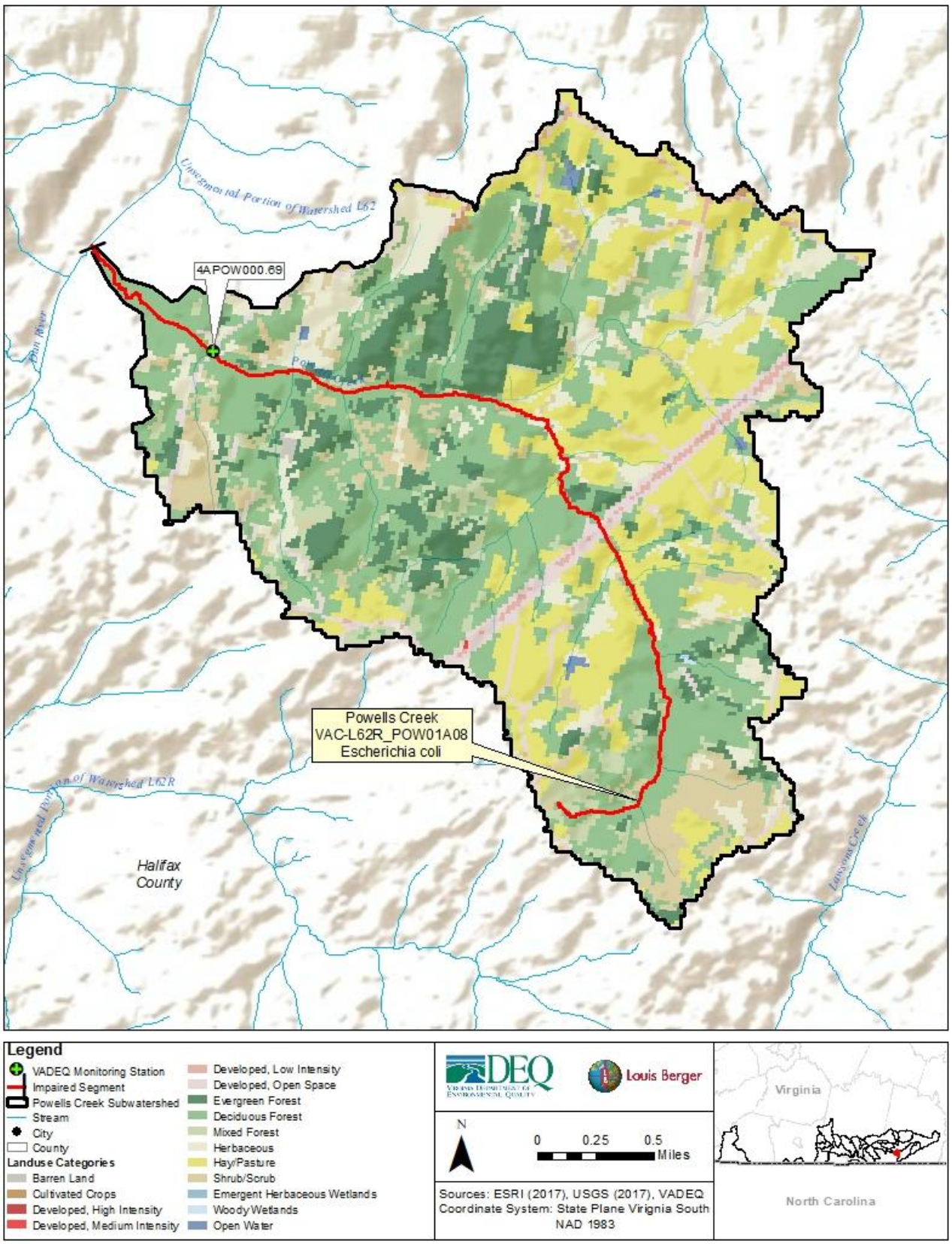

Figure 3-27. Powells Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Powells Creek subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-28).

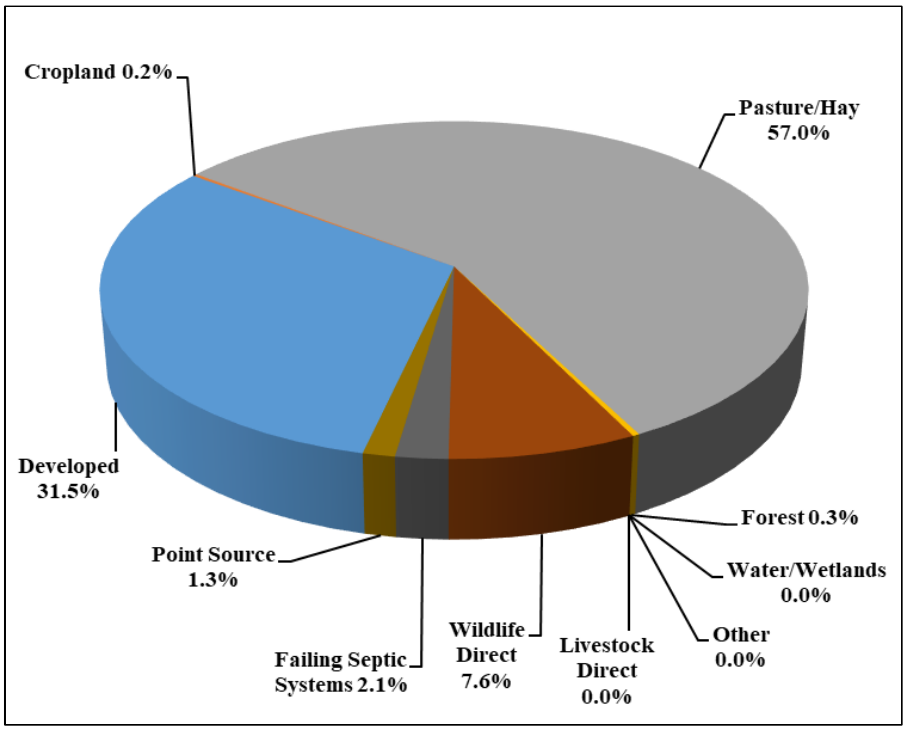

Figure 3-28. Bacteria Sources in Powells Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Powells Creek subwatershed (Table 3-30).

Table 3-28. Powells Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	7.75E+12	3.90E+11	95%
Cropland	5.23E+10	2.62E+09	95%
Pasture/Hay	1.40E+13	7.01E+11	95%
Forest	6.79E+10	6.79E+10	0%
Livestock Direct	2.14E+08	0.00E+00	100%
Wildlife Direct	1.86E+12	1.07E+12	48%
Failing Septic Systems	5.18E+11	0.00E+00	100%
Point Source	3.17E+11	4.34E+09	0%
Total	**2.46E+13**	**2.24E+12**	**91%**

3.2.15 Pumpkin Creek (Nested)

Description of Watershed and Impairment

The portion of Pumpkin Creek in Virginia is located entirely within the City of Danville; however, the headwaters of Pumpkin Creek are located in North Carolina (Figure 3-29). The creek flows north from the Virginia-North Carolina state line before its confluence with the Dan River. The subwatershed has a drainage area of approximately 5,187 acres. The dominant NLCD 2011 land uses consist of developed land (49%) and forest (39%). The majority of the developed land is located in the northern part of the subwatershed.

Pumpkin Creek was first listed as impaired in VADEQ's 2006 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, two out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 4.28 miles of the waterbody (Table 3-31).

Table 3-29. Impairment Summary for Pumpkin Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L60R_PKP01A06	4.28[1]	From the VA/NC line to the mouth on the Dan River	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

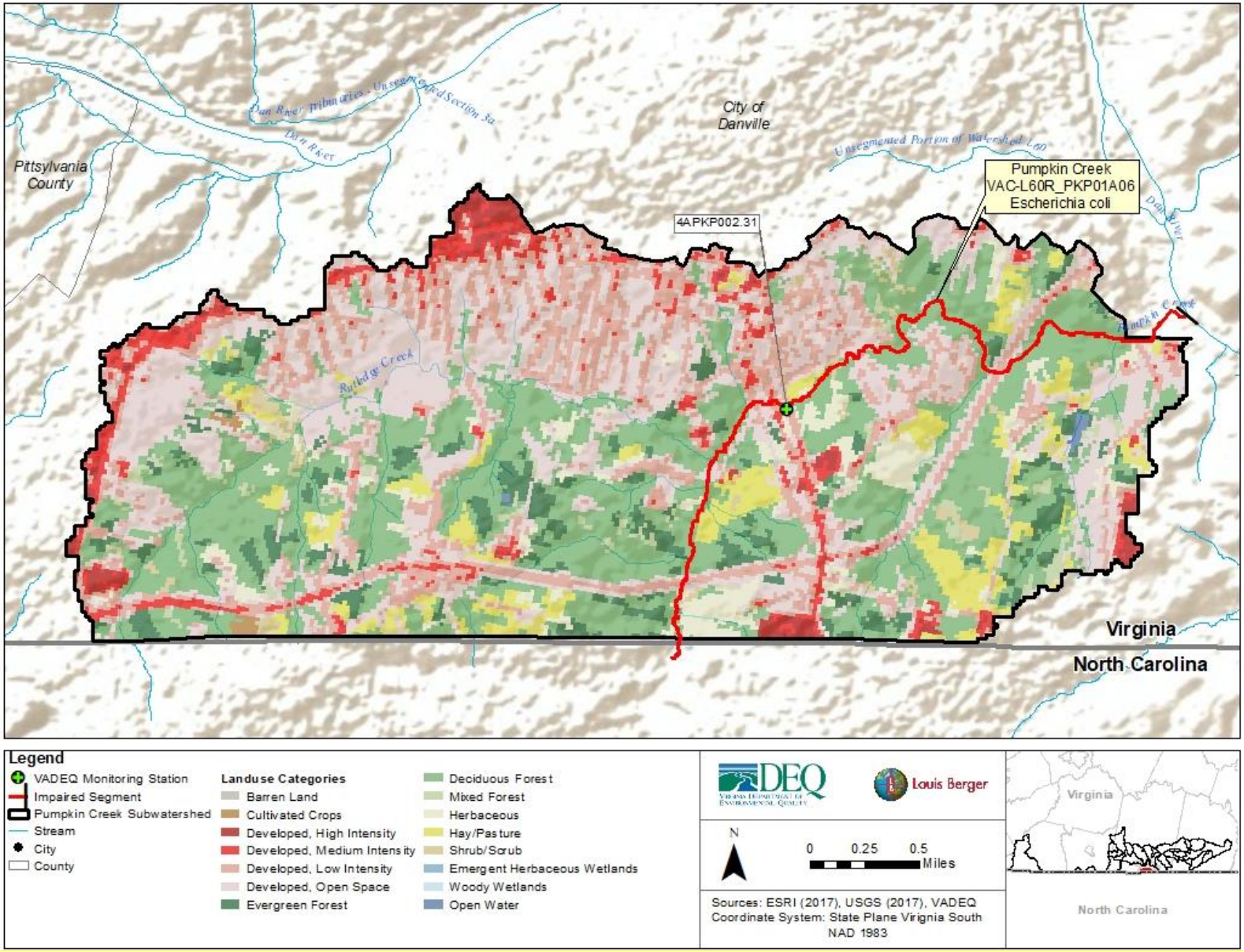

Figure 3-29. Pumpkin Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Pumpkin Creek subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-30).

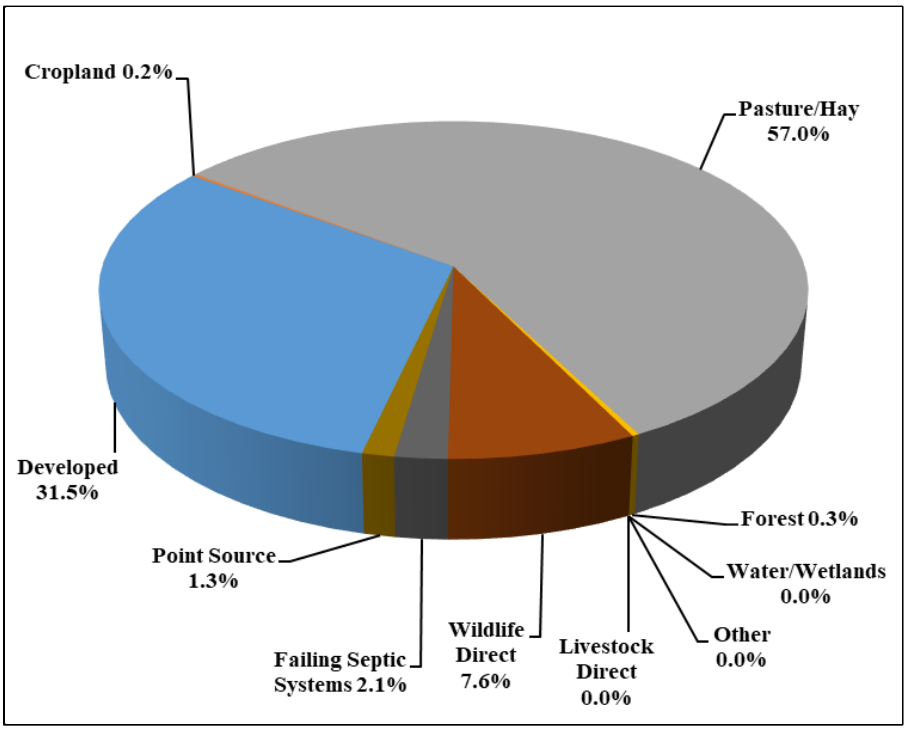

Figure 3-30. Bacteria Sources in Pumpkin Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Pumpkin Creek subwatershed (Table 3-32).

Table 3-30. Pumpkin Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	6.20E+12	3.12E+11	95%
Cropland	4.19E+10	2.09E+09	95%
Pasture/Hay	1.12E+13	5.61E+11	95%
Forest	5.44E+10	5.44E+10	0%
Livestock Direct	1.71E+08	0.00E+00	100%
Wildlife Direct	1.49E+12	8.56E+11	43%
Failing Septic Systems	4.14E+11	0.00E+00	100%
Point Source	2.54E+11	3.48E+09	0%
Total	**1.97E+13**	**1.79E+12**	**91%**

3.2.16 Sandy Creek (East Branch) (Nested)

Description of Watershed and Impairment

The eastern branch of Sandy Creek is located in southeastern Pittsylvania County to the east of the City of Danville (Figure 3-31). The creek flows southeast until its confluence with the Dan River. The drainage area of this subwatershed is approximately 12,238 acres. The dominant NLCD 2011 land uses consist of forest (54%), pasture/hay (25%), and herbaceous lands (10%).

This segment of Sandy Creek was first listed as impaired in VADEQ's 2012 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, four out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 9.41 miles of the waterbody (Table 3-33).

Table 3-31. Impairment Summary for Sandy Creek (East Branch)

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L62R_SLC01A04	9.41[1]	Sandy Creek from its headwaters to the mouth at the Dan River	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

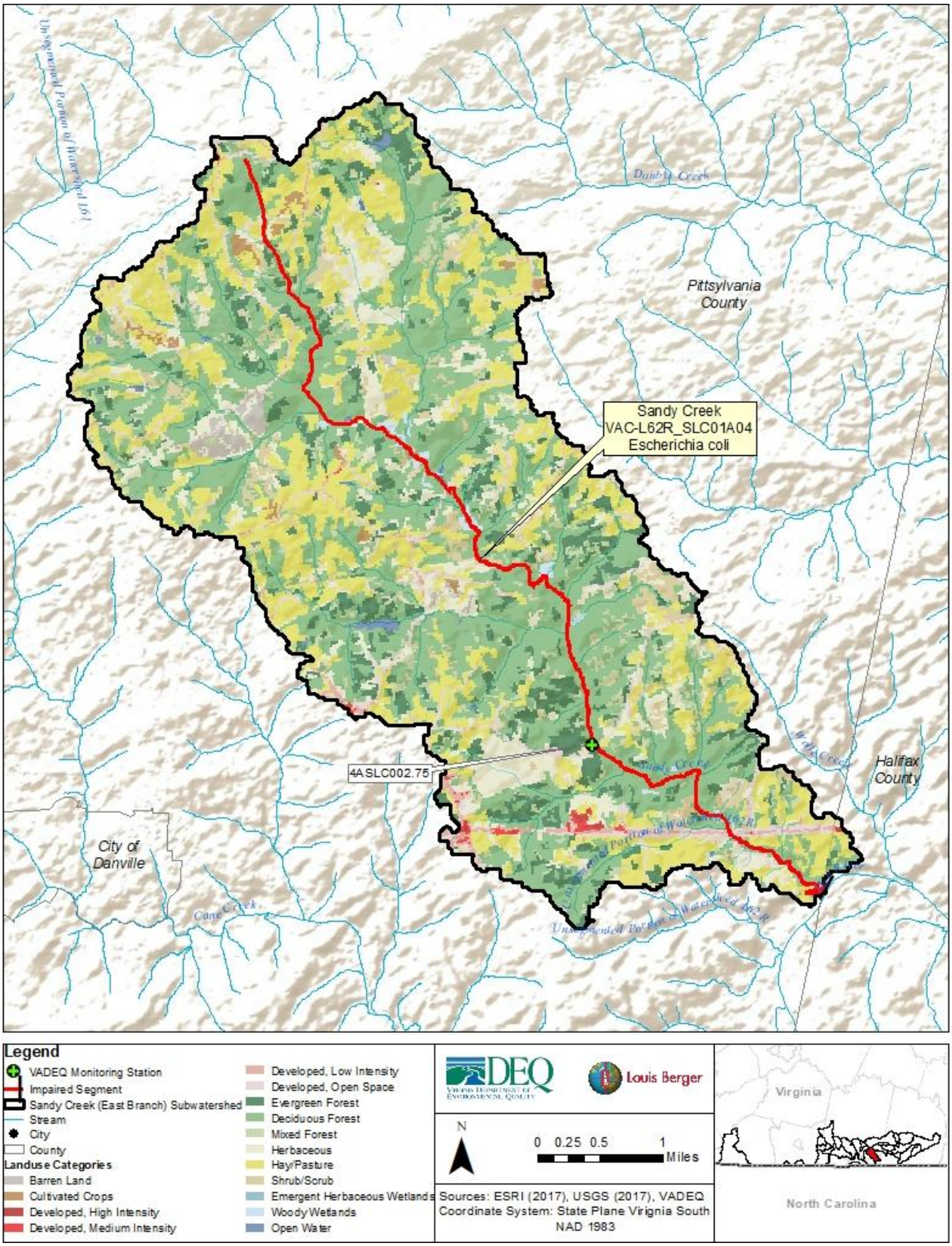

Figure 3-31. Sandy Creek (East Branch) Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Sandy Creek (East Branch) subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-32).

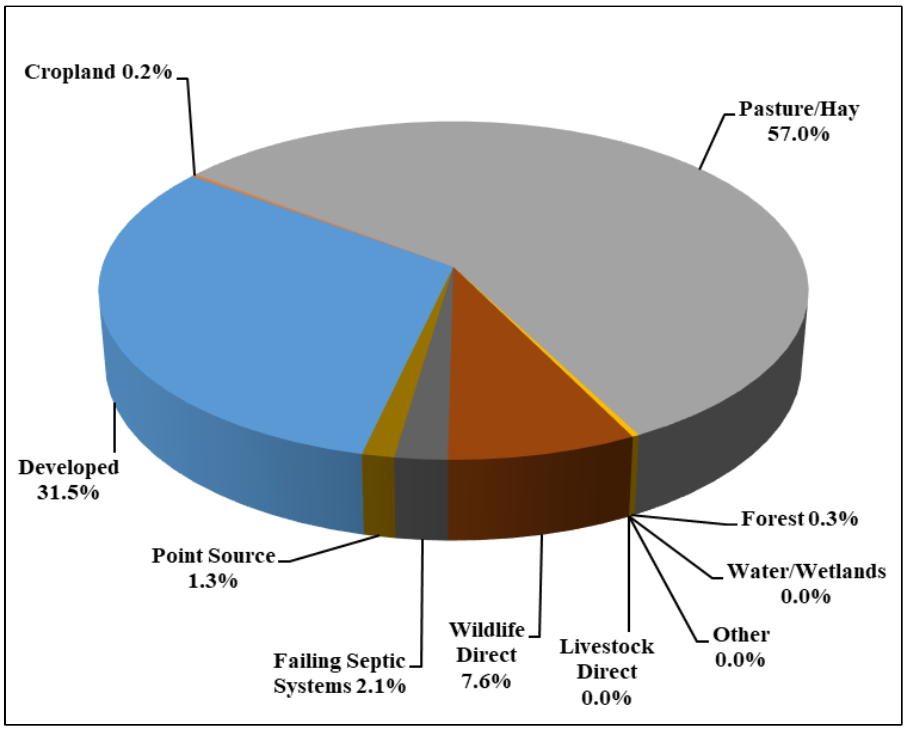

Figure 3-32. Bacteria Sources in Sandy Creek (East Branch) Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Sandy Creek (East Branch) subwatershed (Table 3-34).

Table 3-32. Sandy Creek (East Branch) Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	1.46E+13	7.36E+11	95%
Cropland	9.88E+10	4.94E+09	95%
Pasture/Hay	2.65E+13	1.32E+12	95%
Forest	1.28E+11	1.28E+11	0%
Livestock Direct	4.04E+08	0.00E+00	100%
Wildlife Direct	3.52E+12	2.02E+12	43%
Failing Septic Systems	9.77E+11	0.00E+00	100%
Point Source	5.99E+11	8.20E+09	0%
Total	**4.64E+13**	**4.22E+12**	**91%**

3.2.17 Sandy Creek (West Branch)

Description of Watershed and Impairment

The western branch of Sandy Creek is located in southcentral Pittsylvania County (Figure 3-33). The creek flows south until its confluence with the Dan River in the City of Danville. The drainage area of this subwatershed is approximately 20,654 acres. The dominant NLCD 2011 land uses consist of forest (45%), pasture/hay (26%), and developed land (15%). The developed land associated with the City of Danville is located in the southern portion of the watershed. There are also a scattering of herbaceous lands (10%).

Sandy River was first listed as impaired in VADEQ's 2004 Section 303(d) Total Maximum Daily Load Priority List and Report due to exceedances of the fecal coliform bacteria water quality standard (400 cfu/100 ml instantaneous criterion). After the initial listing, an *E. coli* standard was established, and subsequent listings were based on exceedances of the *E. coli* single sample maximum of 235 cfu/100 ml. Specifically, four out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 9.49 miles of the waterbody (Table 3-35).

Table 3-33. Impairment Summary for Sandy Creek (West Branch)

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L59R_SCR02A02	9.49	Sandy Creek mainstem from near its headwaters downstream to the confluence of Little Sandy Creek.	*Escherichia coli*

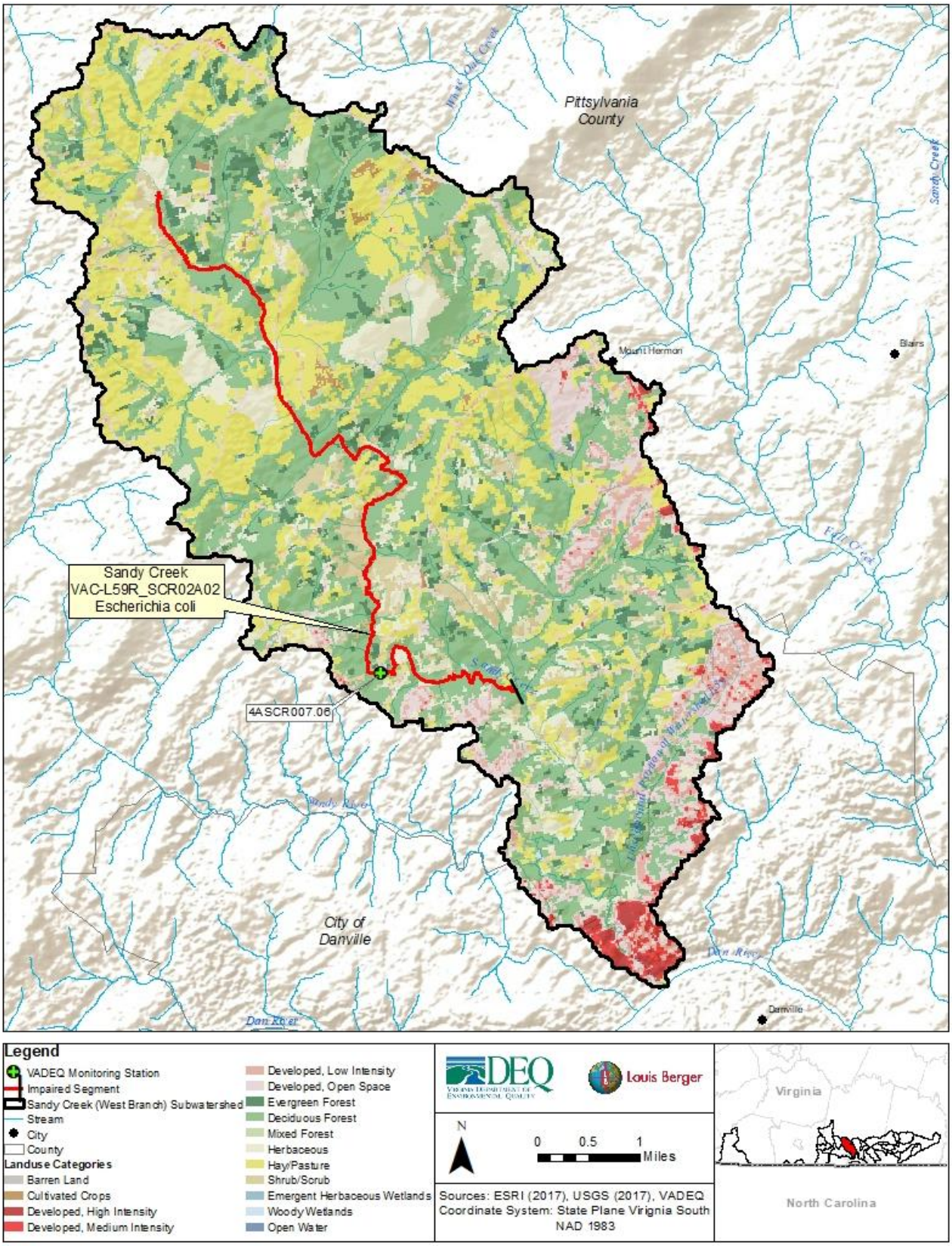

Figure 3-33. Sandy Creek (West Branch) Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Sandy Creek (West Branch) subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-34).

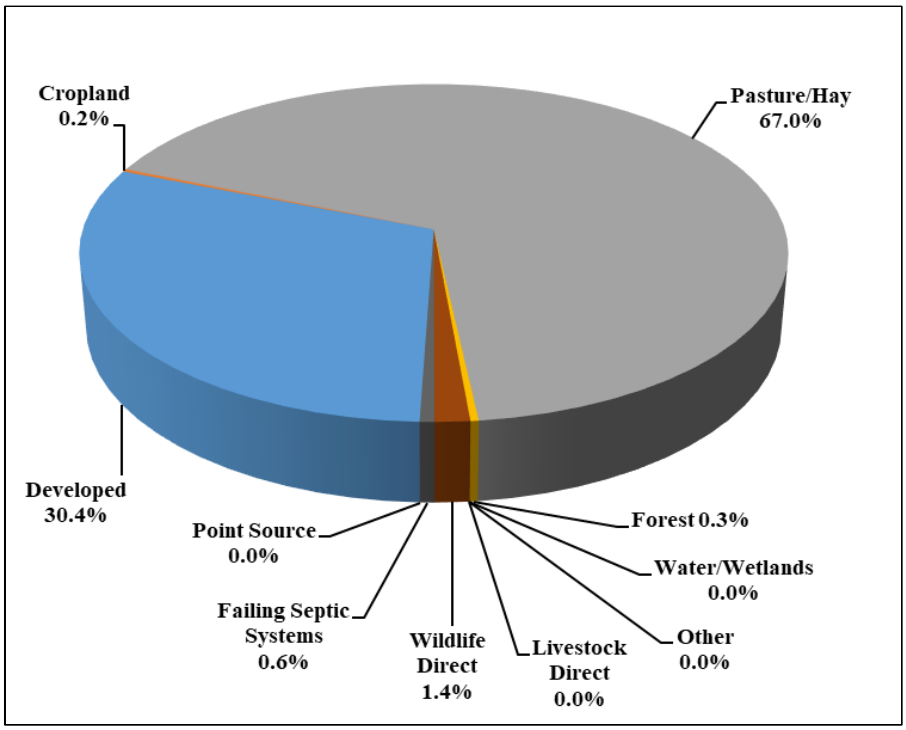

Figure 3-34. Bacteria Sources in Sandy Creek (West Branch) Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Sandy Creek (West Branch) subwatershed (Table 3-36).

Table 3-34. Sandy Creek (West Branch) Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	9.41E+13	2.82E+12	97%
Cropland	7.67E+11	2.30E+10	97%
Pasture/Hay	2.07E+14	6.21E+12	97%
Forest	1.01E+12	1.01E+12	0%
Livestock Direct	1.15E+08	0.00E+00	100%
Wildlife Direct	4.35E+12	4.65E+12	13%
Failing Septic Systems	1.80E+12	0.00E+00	100%
Point Source	-	7.53E+08	0%
Total	**3.09E+14**	**1.47E+13**	**95%**

3.2.18 Sandy River (North) (Nested)

Description of Watershed and Impairment

The impaired headwaters of the Sandy River are located in western Pittsylvania County just north of Callands, Virginia (Figure 3-35). Some reaches within the Sandy River (north) subwatershed are unimpaired; these unimpaired reaches are in the southern portion of the watershed. The drainage area of this subwatershed is approximately 25,135 acres. The dominant land uses (NLCD 2011) consist of forest (56%) and pasture/hay (27%).

This segment of Sandy River was first listed as impaired in VADEQ's 2006 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of Virginia's water quality standard for *E. coli*. Specifically at two stations, three out of 12 samples and six out of 12 samples, respectively, exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 10.79 miles of the waterbody (Table 3-37).

Table 3-35. Impairment Summary for Sandy River (North)

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L58R_SRV04A06	10.79[1]	From its headwaters to its confluence with Bawley Branch	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

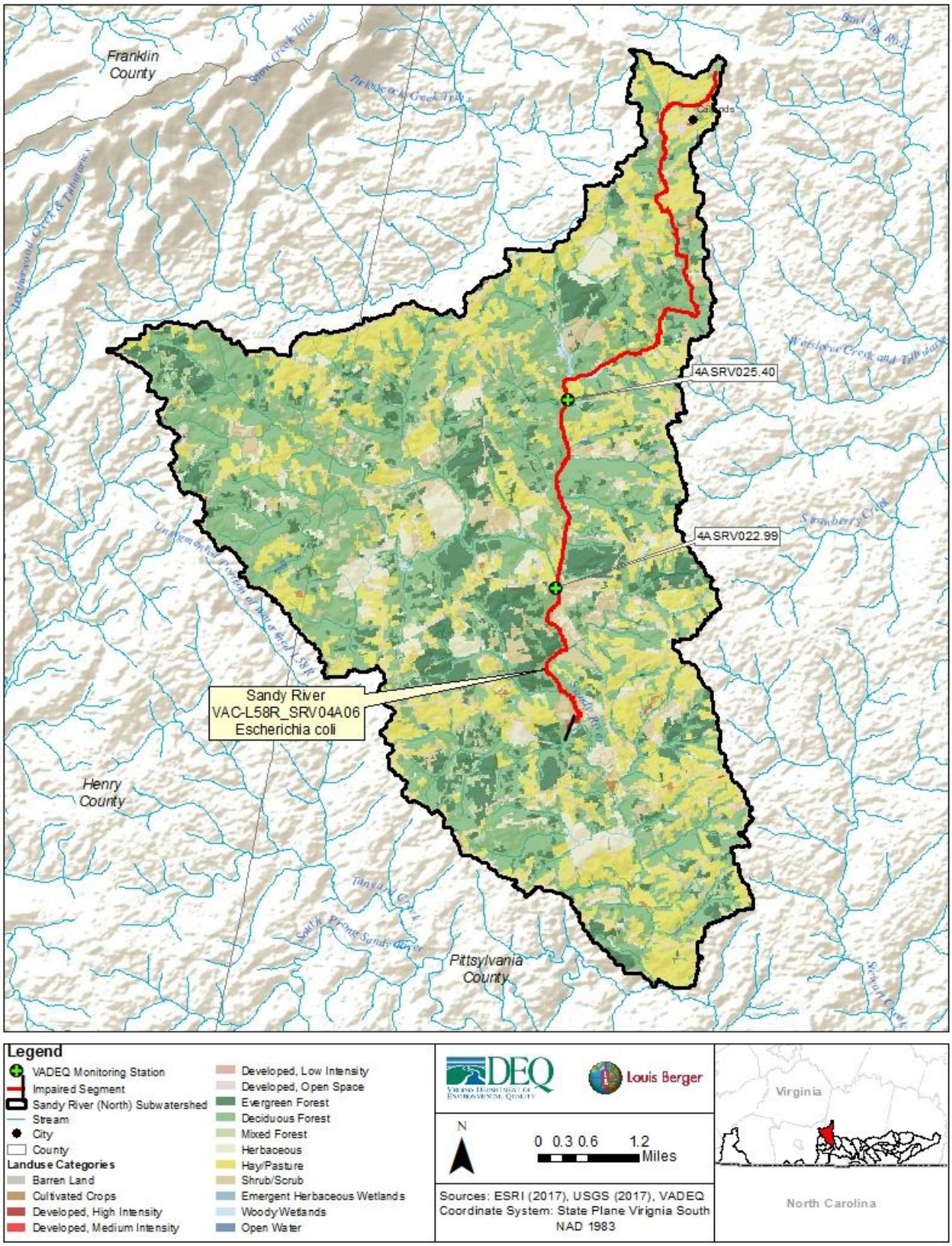

Figure 3-35. Sandy River (North) Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Sandy River (North) subwatershed is nonpoint source runoff from developed and pasture/hay land uses and wildlife direct sources (Figure 3-36).

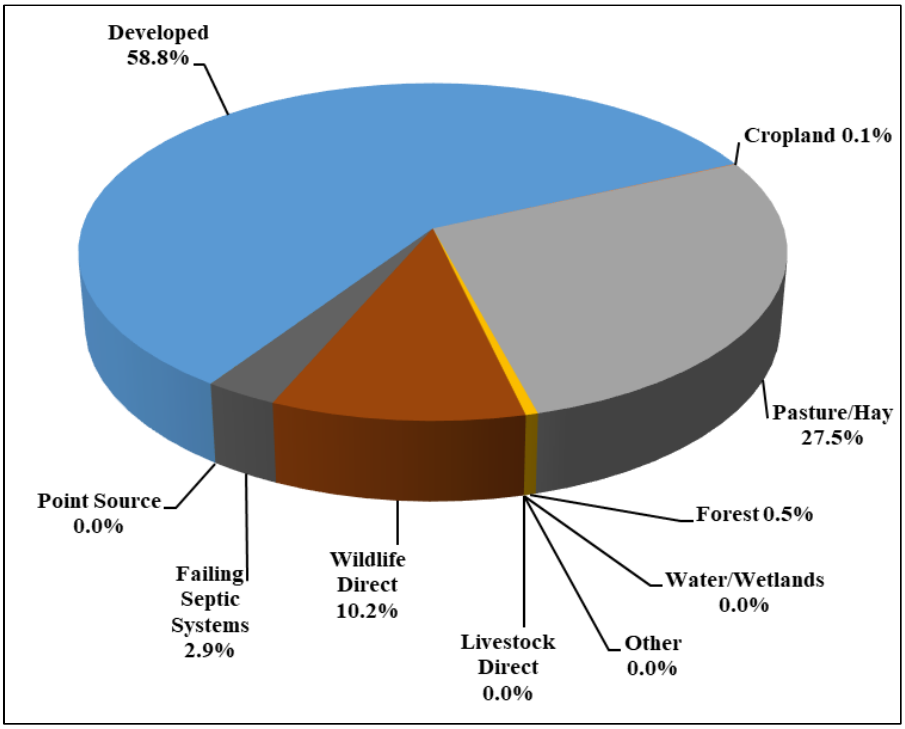

Figure 3-36. Bacteria Sources in Sandy River (North) Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Sandy River (North) subwatershed (Table 3-38).

Table 3-36. Sandy River (North) Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	1.68E+14	5.04E+12	97%
Cropland	1.56E+11	4.69E+09	97%
Pasture/Hay	7.88E+13	2.36E+12	97%
Forest	1.42E+12	1.42E+12	0%
Livestock Direct	2.03E+09	0.00E+00	100%
Wildlife Direct	2.91E+13	1.97E+13	42%
Failing Septic Systems	8.39E+12	0.00E+00	100%
Point Source	7.63E+09	1.04E+08	0%
Total	**2.86E+14**	**2.85E+13**	**90%**

3.2.19 Sandy River (South)

Description of Watershed and Impairment

The impaired segment of Sandy River (South) is located in western Pittsylvania County although the subwatershed begins in eastern Henry County (Figure 3-37). Some reaches within the Sandy River (south) subwatershed are unimpaired; these unimpaired reaches are in the northern portion of the watershed. The unimpaired river flows in a southeasterly direction before it becomes impaired around the City of Danville and finally drains to the Dan River. The subwatershed drains approximately 29,091 acres. The dominant land use (2011 NLCD) is forest (52%) and pasture/hay (26%). Some developed land (11%) is found along the southern portion of the subwatershed associated with the City of Danville.

Sandy River was first listed as impaired in VADEQ's 2002 Section 303(d) Total Maximum Daily Load Priority List and Report due to exceedances of the fecal coliform bacteria water quality standard (400 cfu/100 ml instantaneous criterion). After the initial listing, an *E. coli* standard was established, and subsequent listings were based on exceedances of the *E. coli* single sample maximum of 235 cfu/100 ml. Specifically, six out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 7.23 miles of the waterbody (Table 3-39).

Table 3-37. Impairment Summary for Sandy River (South)

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L58R_SRV01A00	7.23	Sandy River mainstem from the Hickory Forest Creek mouth downstream to the Sandy River confluence on the Dan River.	*Escherichia coli*

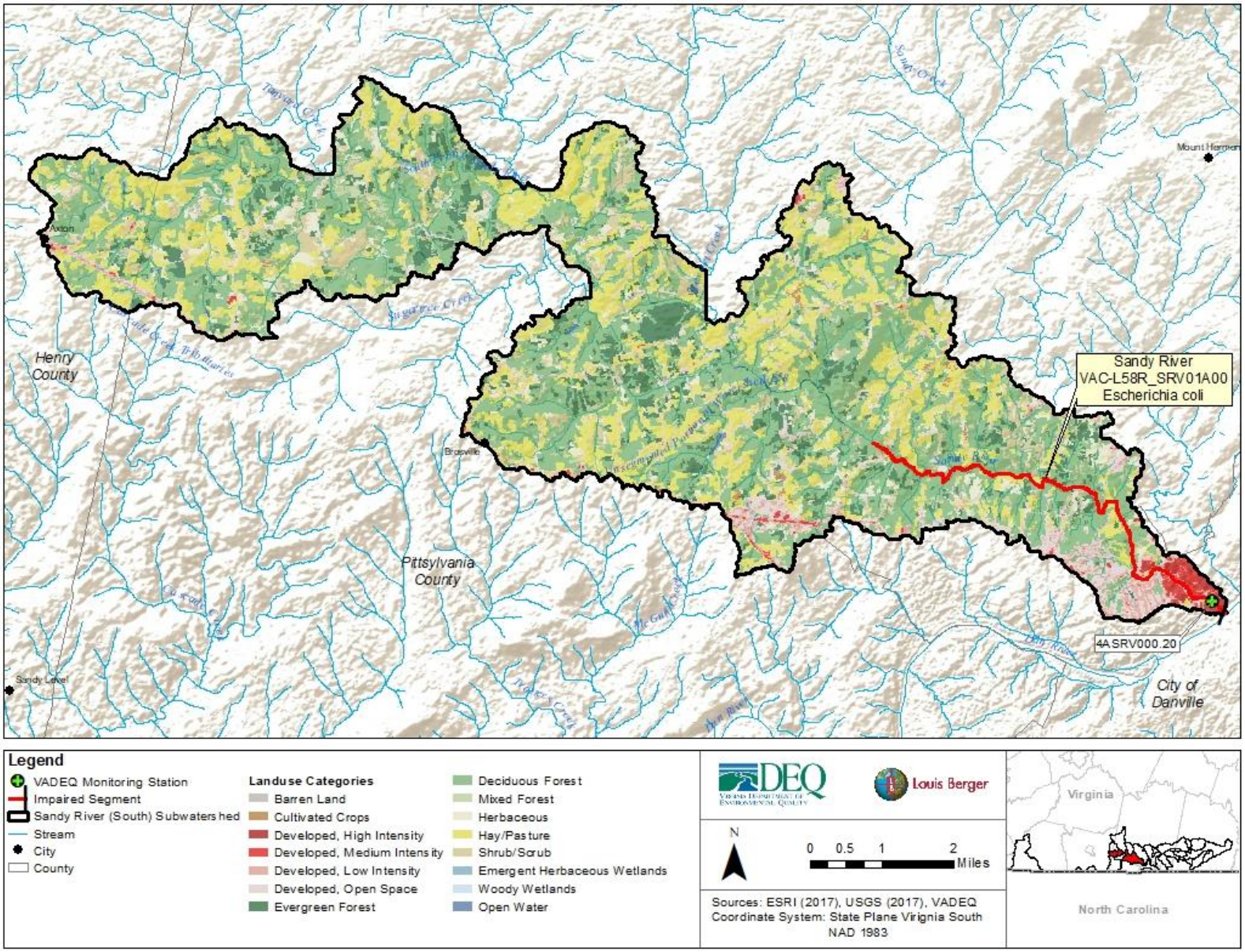

Figure 3-37. Sandy River (South) Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Sandy River (South) subwatershed is nonpoint source runoff from developed and pasture/hay land uses and wildlife direct sources (Figure 3-38).

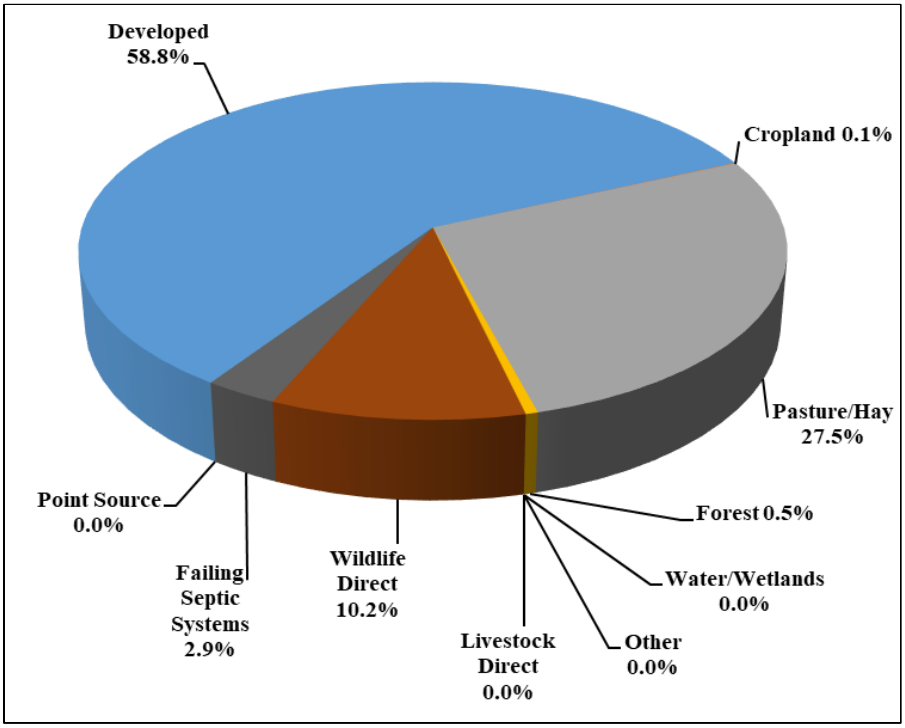

Figure 3-38. Bacteria Sources in Sandy River (South) Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Sandy River (South) subwatershed (Table 3-40).

Table 3-38. Sandy River (South) Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	1.95E+14	5.84E+12	97%
Cropland	1.81E+11	5.43E+09	97%
Pasture/Hay	9.12E+13	2.74E+12	97%
Forest	1.64E+12	1.64E+12	0%
Livestock Direct	2.35E+09	0.00E+00	100%
Wildlife Direct	3.37E+13	2.27E+13	33%
Failing Septic Systems	9.72E+12	0.00E+00	100%
Point Source	8.83E+09	1.21E+08	0%
Total	**3.31E+14**	**3.30E+13**	**90%**

3.2.20 Stewart Creek (Nested)

Description of Watershed and Impairment

Stewart Creek is located in southwestern Pittsylvania County (Figure 3-39). The creek flows south until its confluence with the Sandy River. The drainage area of this subwatershed is approximately 9,075 acres. The dominant NLCD 2011 land uses consist of forest (46%) and pasture/hay land (34%).

Stewart Creek was first listed as impaired in VADEQ's 2008 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, three out of 12 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 7.34 miles of the waterbody (Table 3-41).

Table 3-39. Impairment Summary for Stewart Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L58R_SWA01A08	7.34[1]	Stewart Creek from its headwaters to its mouth on Sandy River	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

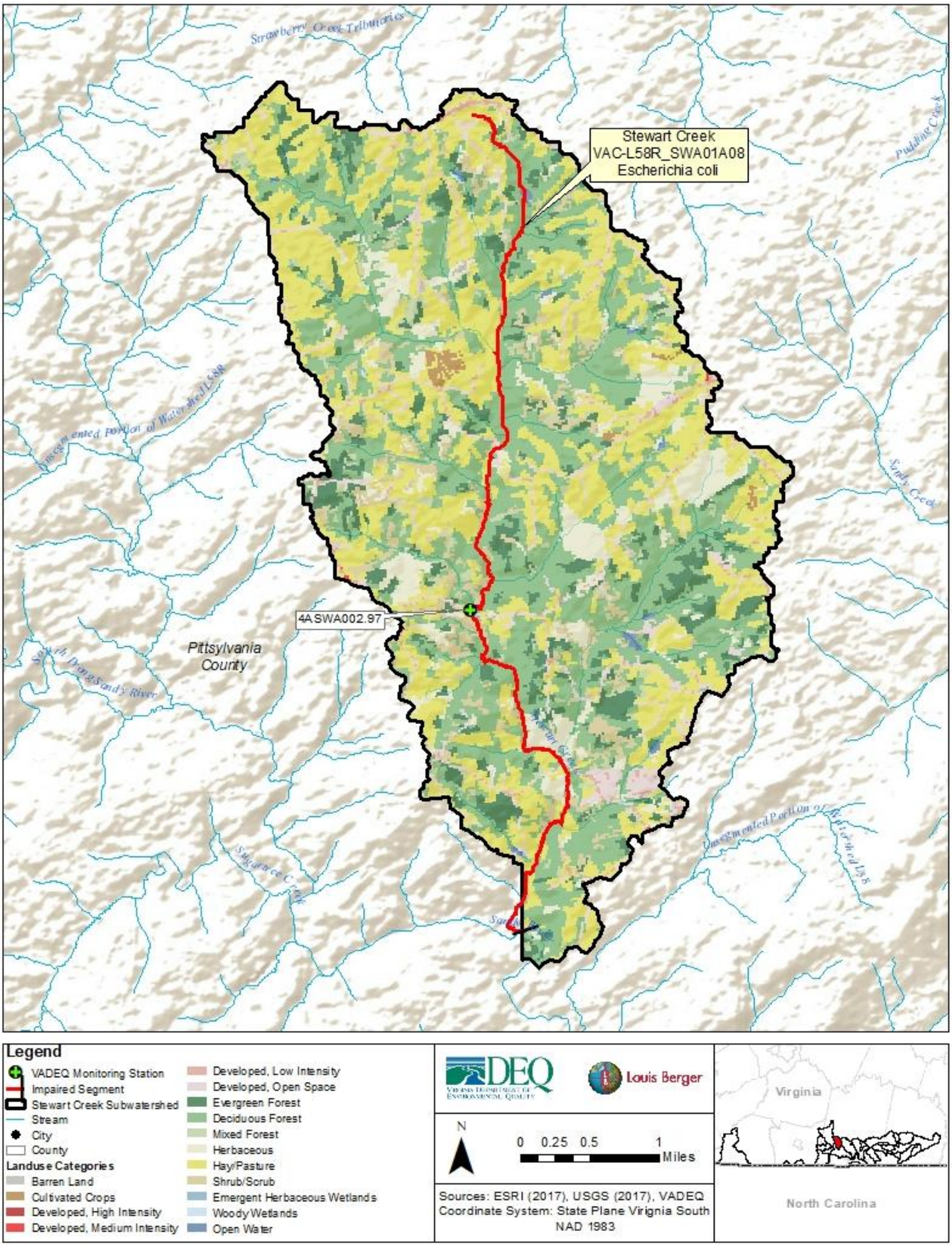

Figure 3-39. Stewart Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Stewart Creek subwatershed is nonpoint source runoff from developed and pasture/hay land uses and wildlife direct sources (Figure 3-40).

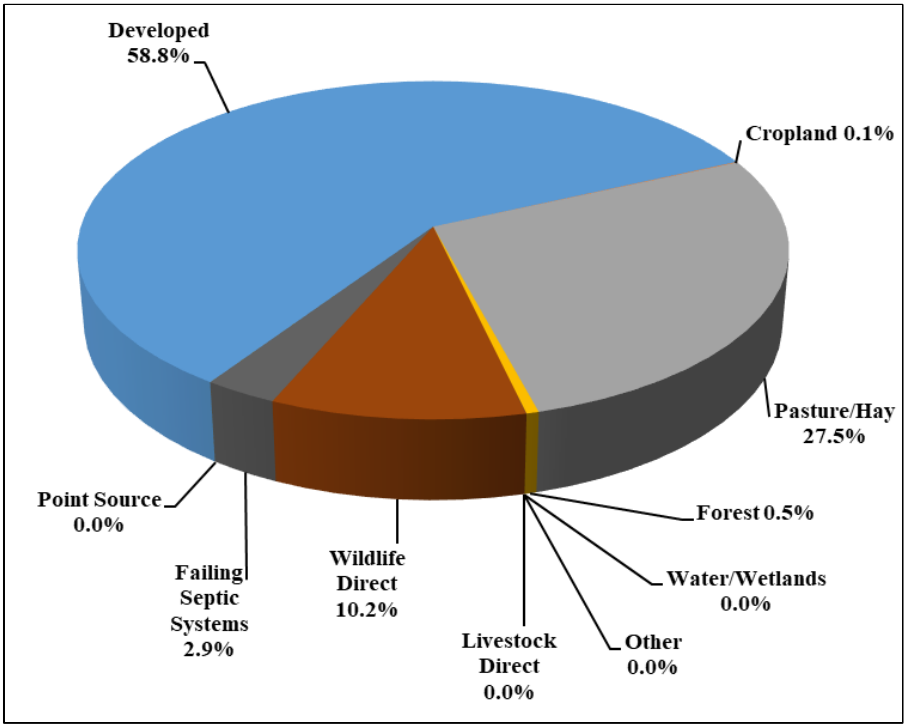

Figure 3-40. Bacteria Sources in Stewart Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Stewart Creek subwatershed (Table 3-42).

Table 3-40. Stewart Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	6.07E+13	1.82E+12	97%
Cropland	5.64E+10	1.69E+09	97%
Pasture/Hay	2.85E+13	8.54E+11	97%
Forest	5.12E+11	5.12E+11	0%
Livestock Direct	7.34E+08	0.00E+00	100%
Wildlife Direct	1.05E+13	7.09E+12	33%
Failing Septic Systems	3.03E+12	0.00E+00	100%
Point Source	2.75E+09	3.77E+07	0%
Total	**1.03E+14**	**1.03E+13**	**90%**

3.2.21 Stokes Creek (Nested)

Description of Watershed and Impairment

Stokes Creek is located in southern Halifax County and flows north until its confluence with Lawsons Creek (Figure 3-41). The subwatershed has a drainage area of approximately 8,337 acres. The dominant land uses (2011 NLCD) are forest (44%) and pasture/hay (19%) with a scattering of herbaceous lands (15%).

Stokes Creek was first listed as impaired in VADEQ's 2014 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, two out of 11 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 6.36 miles of the waterbody (Table 3-43).

Table 3-41. Impairment Summary for Stokes Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L64R_SKS01A08	6.36[1]	Stokes Creek from its headwaters to its mouth on Lawsons Creek	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

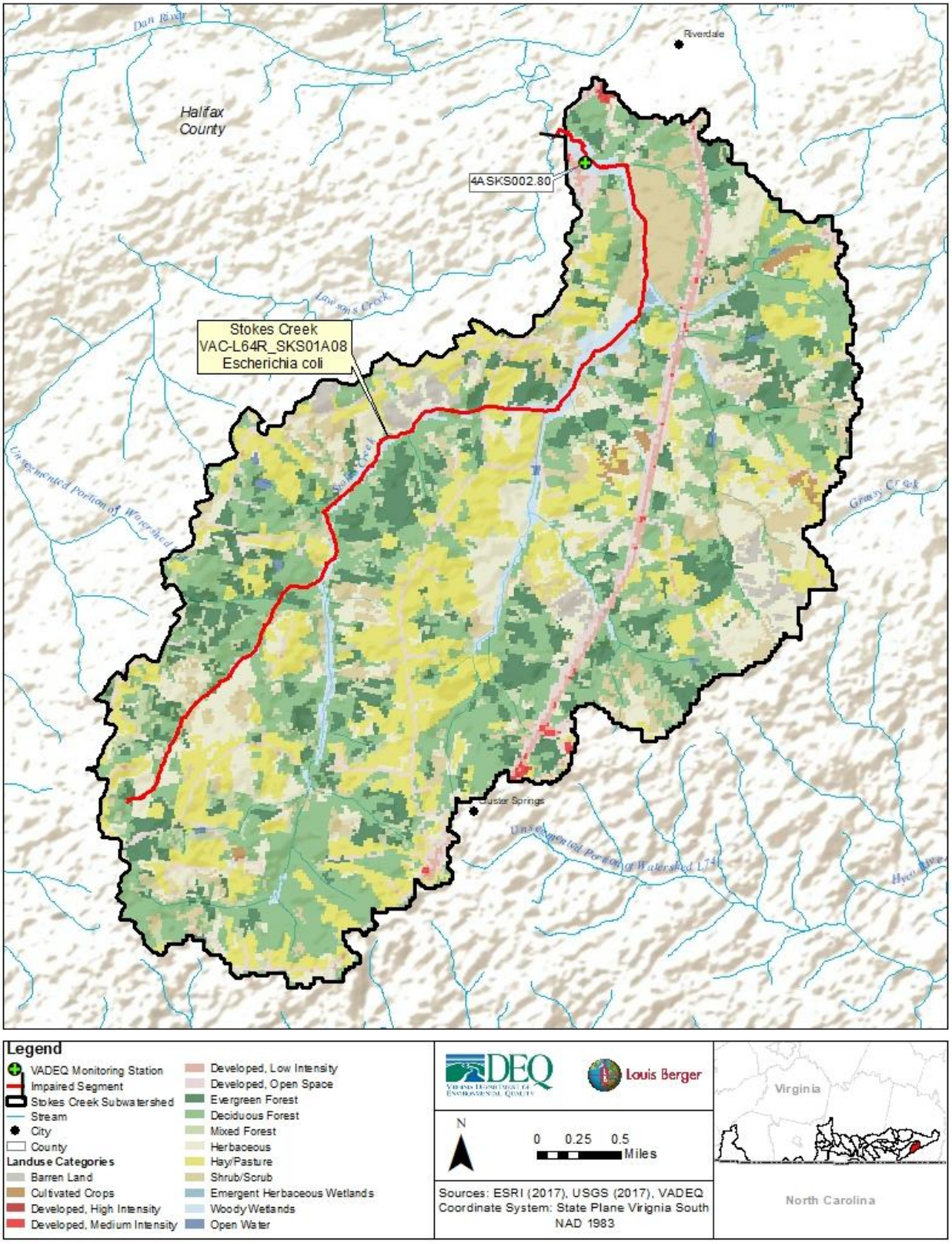

Figure 3-41. Stokes Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Stokes Creek subwatershed is nonpoint source runoff from pasture/hay and developed land uses (Figure 3-42).

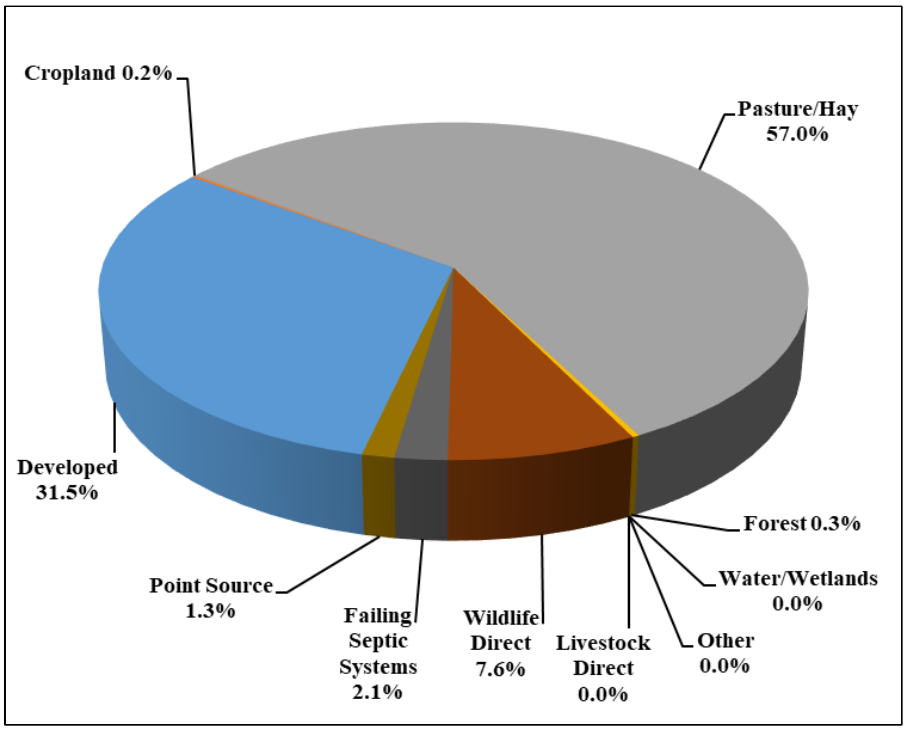

Figure 3-42. Bacteria Sources in Stokes Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Stokes Creek subwatershed (Table 3-44).

Table 3-42. Stokes Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	9.96E+12	5.01E+11	95%
Cropland	6.73E+10	3.37E+09	95%
Pasture/Hay	1.80E+13	9.02E+11	95%
Forest	8.74E+10	8.74E+10	0%
Livestock Direct	2.75E+08	0.00E+00	100%
Wildlife Direct	2.40E+12	1.38E+12	43%
Failing Septic Systems	6.66E+11	0.00E+00	100%
Point Source	4.08E+11	5.59E+09	0%
Total	**3.16E+13**	**2.88E+12**	**91%**

3.2.22 Sugartree Creek (Nested)

Description of Watershed and Impairment

The headwaters of Sugartree Creek are located in western Pittsylvania County (Figure 3-43). The creek flows northeast until its confluence with Sandy River. The subwatershed has a drainage area of approximately 5,210 acres. The dominant land uses (2011 NLCD) are forest (54%) and pasture/hay (20%) with a scattering of herbaceous lands (12%).

Sugartree Creek was first listed as impaired in VADEQ's 2008 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of Virginia's water quality standard for *E. coli*. Specifically, three out of 10 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 6.97 miles of the waterbody (Table 3-9).

Table 3-43. Impairment Summary for Sugartree Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L58R_SUT01A08	6.97[1]	Sugartree Creek from its headwaters to its mouth on Sandy River	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

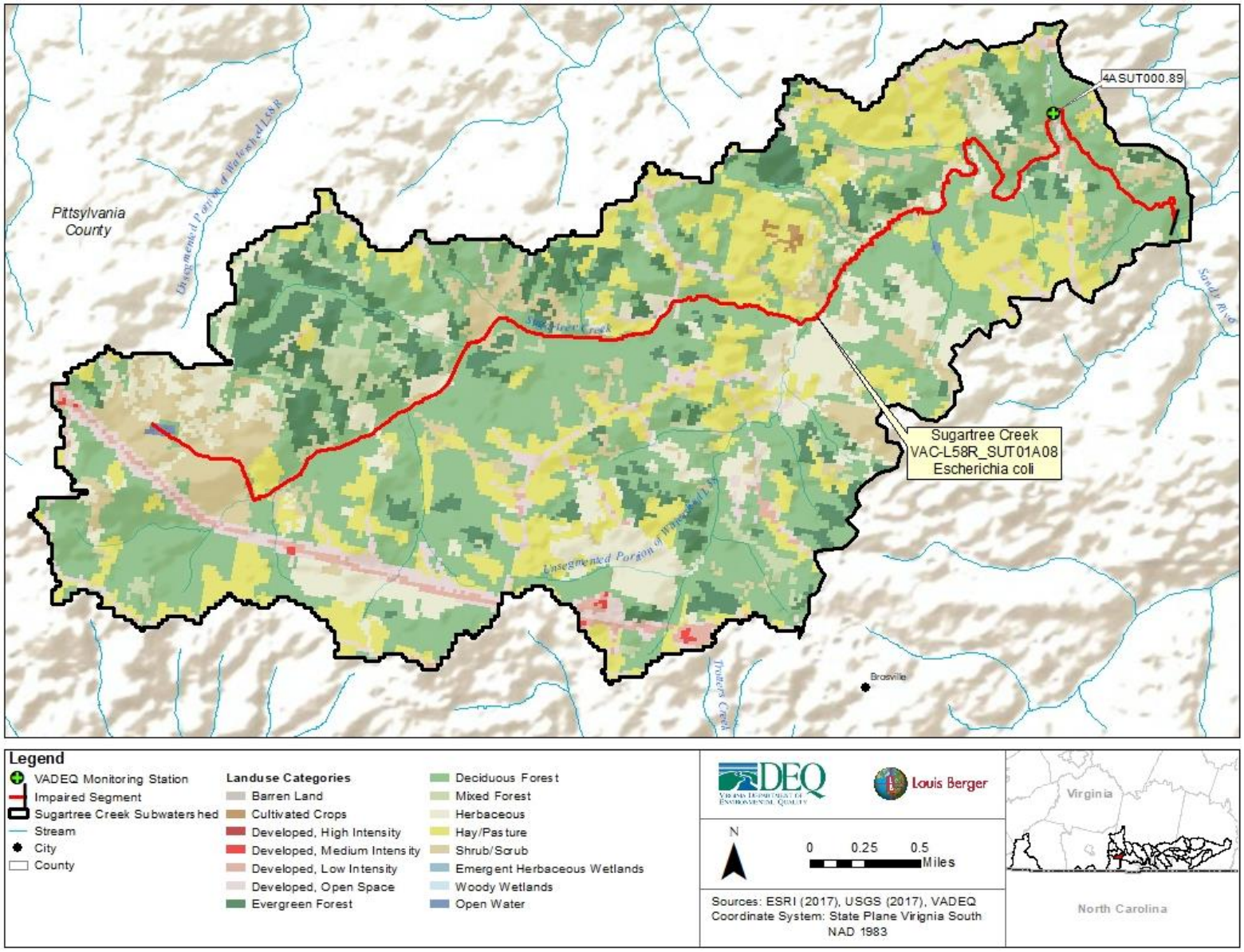

Figure 3-43. Sugartree Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Sugartree Creek subwatershed is nonpoint source runoff from developed and pasture/hay land uses and wildlife direct sources (Figure 3-44).

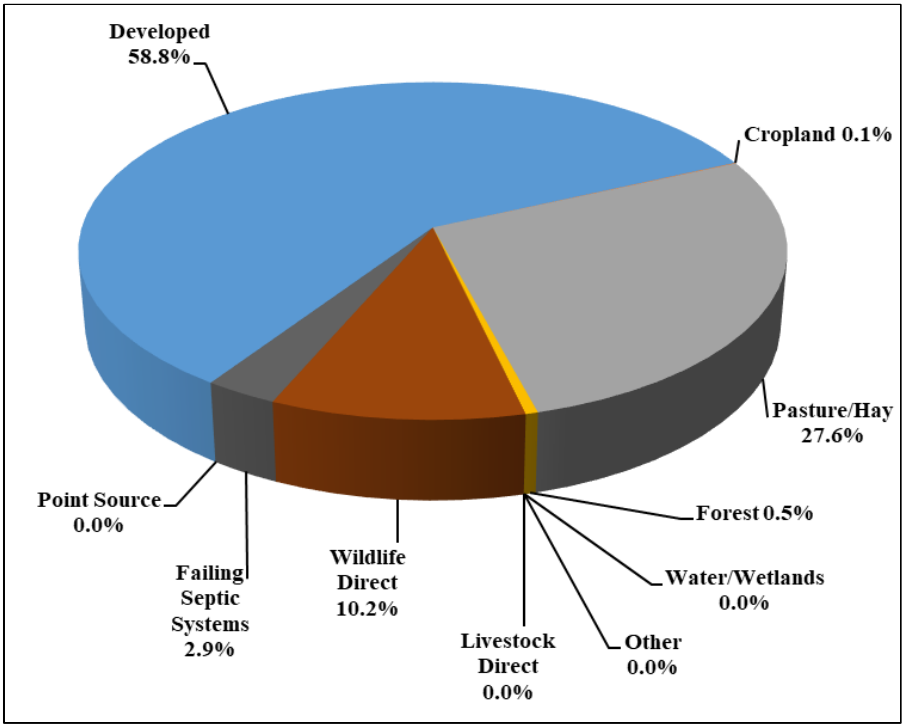

Figure 3-44. Bacteria Sources in Sugartree Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Sugartree Creek subwatershed (Table 3-46).

Table 3-44. Sugartree Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	3.48E+13	1.05E+12	97%
Cropland	3.24E+10	9.72E+08	97%
Pasture/Hay	1.63E+13	4.90E+11	97%
Forest	2.94E+11	2.94E+11	0%
Livestock Direct	4.21E+08	0.00E+00	100%
Wildlife Direct	6.04E+12	4.07E+12	33%
Failing Septic Systems	1.74E+12	0.00E+00	100%
Point Source	1.58E+09	2.16E+07	0%
Total	**5.93E+13**	**5.90E+12**	**90%**

3.2.23 Tanyard Creek (Nested)

Description of Watershed and Impairment

The impaired segment of Tanyard Creek is located in western Pittsylvania County (Figure 3-45). The creek flows south and east until its confluence with the South Prong Sandy River. The drainage area of this subwatershed is approximately 8,741 acres. The dominant NLCD 2011 land uses consist of forest (54%) and pasture/hay (36%). The forest land occurs throughout the watershed interspersed with portions of pasture/hay land.

Tanyard Creek was first listed as impaired in VADEQ's 2006 305(b)/303(d) Water Quality Assessment Integrated Report due to exceedances of the *E. coli* water quality standard. Specifically, two out of 11 samples exceeded the 235 cfu/100 ml *E. coli* single sample maximum. Due to these exceedances, the primary contact recreation use was not supported along 2.86 miles of the waterbody (Table 3-47).

Table 3-45. Impairment Summary for Tanyard Creek

Assessment Unit	Length (miles)	Boundaries of Impaired Segments	Cause
VAC-L58R_TRD01A06	2.86[1]	From the confluence of Glady Fork to South Prong Sandy River	*Escherichia coli*

[1]Segment was nested with applicable TMDLs during the 2014 303(d)/305(b) Integrated Report.

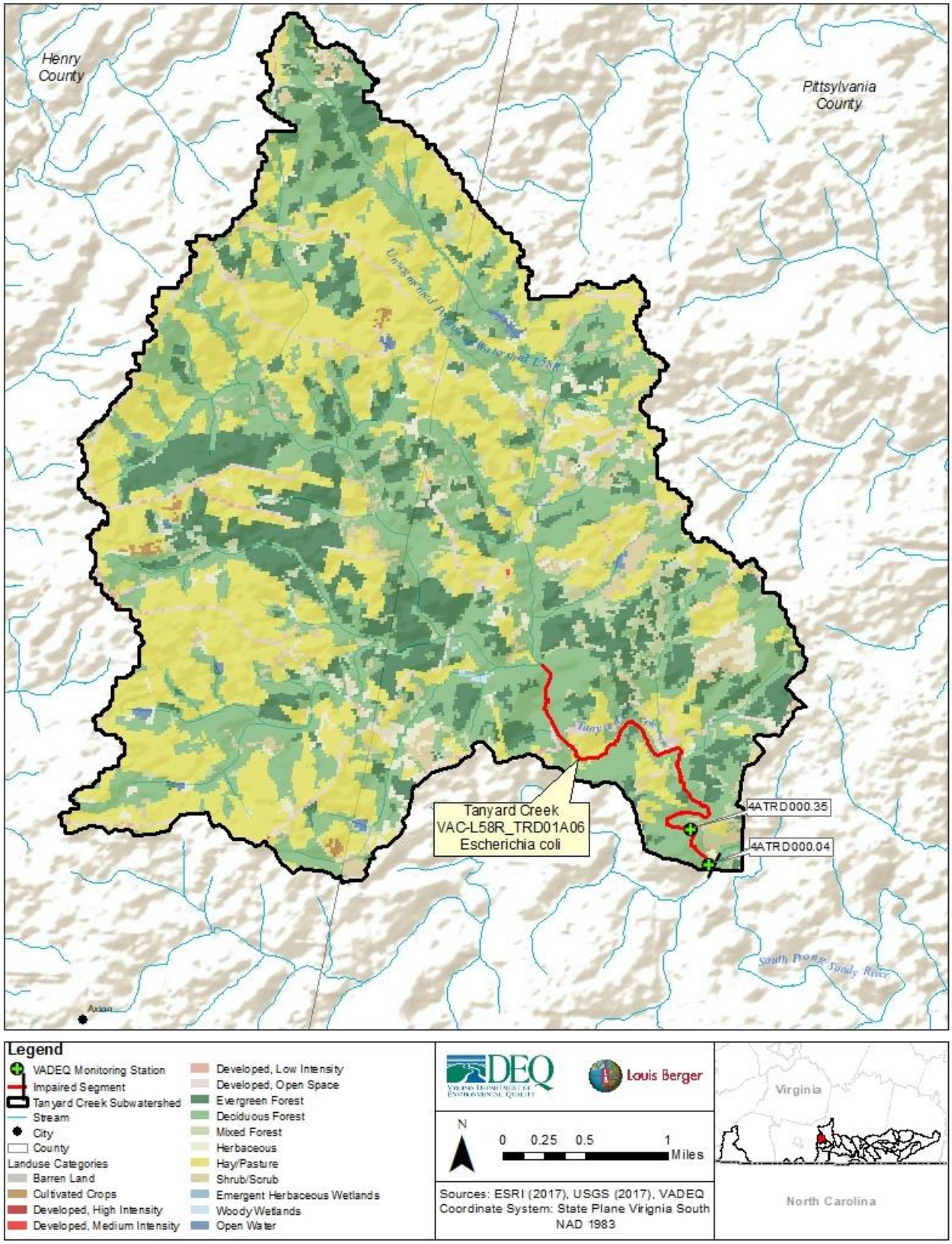

Figure 3-45. Tanyard Creek Subwatershed

Bacteria Sources

The primary contributor to bacteria loading in the Tanyard Creek subwatershed is nonpoint source runoff from developed and pasture/hay land uses and wildlife direct sources (Figure 3-46).

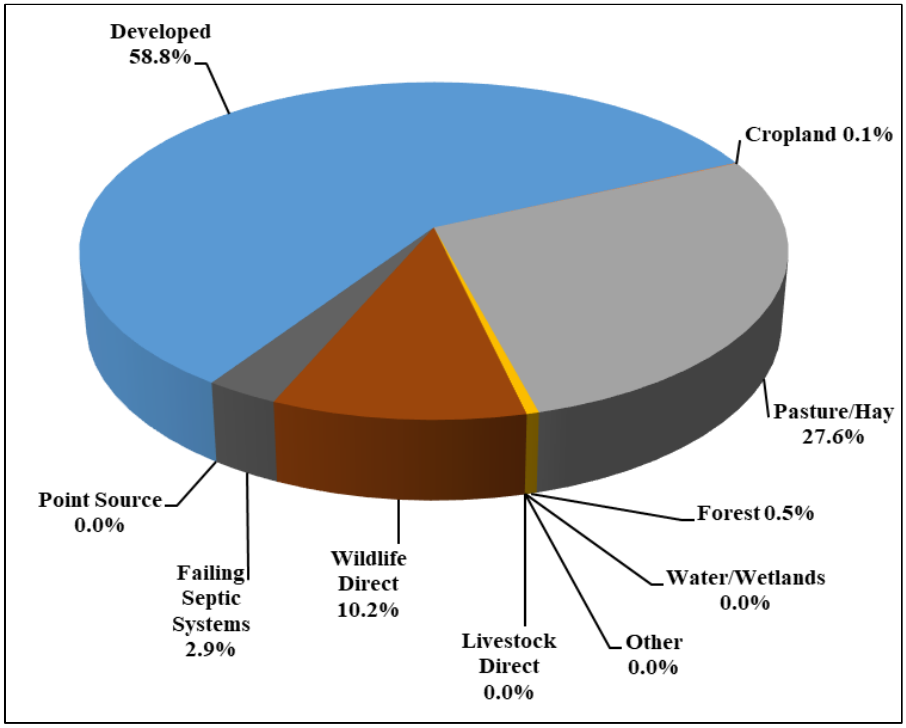

Figure 3-1. Bacteria Sources in Tanyard Creek Subwatershed

Bacteria Allocation Summary/Load Reduction

Reductions from bacteria sources are presented in the load allocation table for the Tanyard Creek subwatershed (Table 3-48).

Table 3-46. Tanyard Creek Load Allocation for *E. coli*

2011 Land Use/Source	Annual Average *E. coli* Loads (cfu/year)		Percent Reduction
	Existing	Allocation	
Developed	5.85E+13	1.75E+12	97%
Cropland	5.44E+10	1.63E+09	97%
Pasture/Hay	2.74E+13	8.22E+11	97%
Forest	4.94E+11	4.94E+11	0%
Livestock Direct	7.07E+08	0.00E+00	100%
Wildlife Direct	1.01E+13	6.83E+12	33%
Failing Septic Systems	2.92E+12	0.00E+00	100%
Point Source	2.65E+09	3.63E+07	0%
Total	**9.95E+13**	**9.90E+12**	**90%**

4.0 Public Participation

Public participation measures in the development of a watershed implementation plan educate and inform the local stakeholders about the issues, and solicit input on appropriate solutions. Meetings with the public, steering committees, and working groups (agricultural, government, and residential) were held to achieve these goals. Table 4-1 shows the meeting date, specific type, location, and number of attendees. Minutes and notes from the meetings were available on online throughout the duration of IP development and are presented in Appendix B.

Table 4-1. Meetings during Development of the Birch Creek and Dan River TMDL Implementation Plan

Date	Meeting Type	Attendance	Location
08/29/2017	Public Meeting #1	19	Eastern Conference Room, Danville Regional Airport, 424 Airport Drive, Danville, VA 24540
10/03/2017	Government Working Group #1	12	
10/03/2017	Agricultural Working Group #1 and Residential Working Group #1	7	
03/13/2018	Agricultural Working Group #2 and Residential Working Group #2	13	
05/24/2018	Steering Committee Meeting #1	8	Eastern Conference Room, Danville Regional Airport, 424 Airport Drive, Danville, VA 24540
06/05/2018	Public Meeting #2	8	Eastern Conference Room, Danville Regional Airport, 424 Airport Drive, Danville, VA 24540

Stakeholders within a watershed include agencies, organizations, and individuals. Each of these stakeholders has knowledge and interest about existing watershed and water quality issues, conditions, resources, and management activities. By holding different types of meetings, each of these varied groups can provide their specialized input concerning the watershed and best management practices. The informational aspect of the meetings highlight the ongoing progress in the development process as well as the resultant outcomes, thus allowing for public input at several levels of plan development. Public participation could lead to citizen involvement in the

watershed cleanup process by providing knowledge about available pollutant prevention measures and local stakeholder attitudes.

4.1 Public Meetings

The first public meeting for the Birch Creek and Dan River TMDL IP was held on August 29, 2017 with 19 participants. A presentation addressed the overall IP project and process, reviewed the 2004 and 2008 TMDLs, outlined the timeline for implementation plan development, and provided an overview of public participation goals. General descriptions and information were provided on TMDLs, relevant water quality standards, and IP goals and requirements. An overview of the watershed described the existing TMDLs and bacteria sources, and the steps taken to update the information for current conditions including land use. The responsibilities of working groups for residential, agricultural, and government and the steering committee were explained. These include reviewing the IP and assessing corrective actions and strategies and identifying existing practices and controls. VADEQ highlighted the need for citizen volunteers for the different working groups. Working group sign-in sheets were used for the meetings. Input, comments, and questions were solicited from the participants and maps and informational materials were available. Questions from the public addressed sewage disposal, bacteria sources and impairment data, human health and environmental concerns from bacteria, and the cleanup success rate for implementation plans.

The second public meeting for the Birch Creek and Dan River TMDL IP was held on June 5, 2018 with 8 participants. A presentation was given summarizing the impairments and the BMPs that are proposed to address the impairments within each subwatershed. Implementation staging was also explained. Input received at the working group and steering committee meetings was presented as it relates to the numbers and types of BMPs proposed.

4.2 Agricultural/Residential Working Groups Meetings

The agricultural and residential working groups meetings were held on October 3, 2017 with 7 participants and March 13, 2018 with 13 participants. The principal objective of the agricultural and residential working groups is to identify obstacles to implementation of practical solutions to reducing bacteria. The focus for the agricultural group was agricultural bacteria sources; the focus for the residential working group was human and pet bacteria sources.

During the first combined working group meeting, the residential group specifically discussed sewers, on-site sewage disposal, pet waste, and stormwater. Participants were not aware of any issues with sewer overflows, straight pipes, or failing septic systems. There is not a high demand for alternative systems. Local radio, newspapers, and church bulletins would provide the best way to notify the public on available assistance. Education regarding septic system issues would be beneficial and could be provided by local public service authorities, Tri-County Community Action Agency, and the cities and towns through public service announcements. Although some residents in the watershed are aware of the problems caused by pet waste, it is important to keep reminding citizens that pet waste is an issue. There are no active pet waste education campaigns; however, education would best be accomplished through a campaign with mailings, flyers, and outreach at public events. There are few pet waste stations in the area and sometimes they are not well stocked or used. Public knowledge concerning stormwater runoff from residential and urban land areas as a source of bacteria is limited. Overall, not many BMPs of any kind have been implemented in the watershed and meeting participants reported that lack of appropriate funding is a barrier to implementing most BMPs.

During the first combined working group meeting, the agricultural group specifically discussed current practices, funding, and education. In the region, the trend in agriculture is moving from tobacco crops to other row crops, some beef cattle, and small ruminants. Rotational grazing and pasture management, stream exclusion, and nutrient management would be the most appropriate BMPs in the watershed. Local cattle producers seem to be the most interested in grazing management programs and watering systems with less interest in stream fencing. The reason being the lack of funding and support programs for fencing and exclusion practices. Manure storage and biosolids are not an issue in the region; however, there is a need for better management of the highly erodible soils. Virginia Cooperative Extension staff and mailings would likely be the best way to inform local farmers about conservation programs. General education and outreach could best be accomplished by organizations such as the soil and water conservation districts (SWCDs), Cattleman's Association, Farm Bureau, and non-governmental organizations. General questions from the participants centered on the TMDL and IP, funding, and future review of implementation practices.

In the second combined agricultural and residential working group meeting, participants were presented with preliminary BMP types, numbers, and costs and the process for developing these values. The meeting participants used their local knowledge to evaluate the proposed BMPs, make comments, provide updated information, and suggest revisions. The changes and information are to be incorporated into the final IP report. It was noted that a BMP must be included in the IP in order for grant funding to be used for the practice.

4.3 Government Working Group Meetings

The government working group meeting was held on October 3, 2017 with 12 participants. The discussion focused on several broad topics initially introduced in the other working groups including sewage handling and disposal, agricultural programs, stormwater programs for urban runoff, pet waste, other bacteria sources, integration with other local activities and planning, and regulatory controls. Data and information were requested from the localities regarding existing or future planned BMPs including type, age, location, and drainage area, size, or length as well as grant funding opportunities.

The presentation provided the existing sewer handling and disposal data and asked participants for comments. Although the existing wastewater treatment plant has enough capacity for sewer expansion, many residences choose not to connect to sewer. Participants mentioned one additional community for sewer expansion. The City of Danville has a sewer connection ordinance requiring a connection to the sewer system if a home is within 500 feet of a sewer line. Other than routine maintenance of the sanitary sewer system conducted in some areas, there are no other BMPs targeting sewer problems. Participants remarked that there is a need for education to engage citizens on public sanitary sewer issues. Additionally, SWCDs, municipalities, and planning districts could take on grant funding addressing straight pipes and failing septic systems. Participants mentioned some areas with a higher number of failing septic systems.

The interest in agricultural programs is high; however, there is limited funding available for implementation resulting in the SWCDs being unable to assist all interested parties. The SWCDs have limited resources to track voluntary BMPs but could list certain BMPs included in the IP that could be implemented at landowner cost. Additional discussion focused on cost-share

funding, incentives to maintain voluntary BMPs, and participation in practices that would reduce loading from runoff.

Currently local stormwater programs have several efforts underway to address bacteria and sediment including a campaign to label stormwater inlets as "draining to the river" and the monitoring of outfalls in the City of Danville for *E. coli*, under the latest Virginia Pollutant Discharge Elimination System (VPDES)permit. The City of Danville has ten existing stormwater BMPs consisting mostly of extended detention basins. There is at least one existing stream restoration project in the watershed and participants suggested other locations for future restoration projects.

The discussion on pet waste highlighted existing pet waste stations and locations where stations should be installed. In addition to stations, there are other local practices related to pet waste issues and there are areas for enhancement. The City of Danville highlights pet waste on the city website and has specific pet waste disposal areas in the city. Although there would likely be support for a pet waste education campaign in urban areas, the receptiveness to a campaign would be limited elsewhere. Acceptance of an education campaign and the use of pet waste stations would increase if convenience were taken into consideration. It was suggested that Virginia Cooperative Extension would be a good partner to assist with pet waste education campaigns in addition to veterinary offices.

Other topics of discussion included erosion and sediment controls, street sweeping, the need for additional education on stormwater management, and opportunities for outreach in the region.

4.4 Steering Committee Meeting

The first steering committee meeting was held on May 24, 2018 with 8 participants. The draft Birch Creek and Dan River TMDL IP was reviewed by the committee, with the focus on the BMP estimates, goals and milestones, and targeting. The focus of the meeting was to evaluate the proposed BMP types, numbers, and costs for the various categories and the staging milestones. The steering committee members were presented with the proposed BMPs and provided suggestions, comments, and revisions to the preliminary version. The changes and information provided are to be incorporated into the final IP report.

5.0 Implementation Actions

Implementation actions necessary to reduce the bacteria loads were identified through stakeholder input, public participation, and review of land use/source data and pollutant delivery mechanisms. This chapter focuses on the controllable sources of bacteria loadings in the watershed. These controllable sources include direct deposition of bacteria by livestock, overland runoff from agricultural land (cropland and pasture), overland runoff from residential and urban land, failing septic systems and straight pipes, and streambank erosion. Described in this chapter are the following topics:

- Selection and quantification of appropriate implementation actions to reduce bacteria loading
- Steps needed toward meeting water quality standards
- Associated costs and benefits of the actions associated with implementing agricultural, residential, and urban BMPs and technical assistance associated with implementing agricultural, residential, and non-MS4 urban BMPs.

The subsequent chapter (Chapter 6) provides the IP actions or each watershed among three stages as an iterative process toward meeting water quality goals.

5.1 Identification of Control Measures

Proposed measures to control bacteria were identified through multiple sources. Several BMPs were suggested in the 2004 and 2008 TMDL reports including livestock exclusion, septic system BMPs, riparian buffers, and pet waste management (VADEQ 2004, 2008). Appropriate control measures were also identified through review of published materials such as stormwater BMP literature and the Virginia Agricultural Cost Share BMP Manual. Stakeholders at working group meetings provided input on existing and potential control measures. Additionally, some measures have been proposed based on existing Virginia TMDL IPs with similar watershed conditions.

Quantifiable BMPs proposed in this IP are listed in Table 5-1 grouped by land use (i.e., agricultural, residential, or urban) or pollution source associated with the BMPs. Also listed are bacteria removal efficiencies of each BMP and associated source documents.

Table 5-47. Best Management Practice Efficiency			
BMP Type	**BMP**	**Bacteria Removal Efficiency (%)**	**Reference**
Agricultural			
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	100	(1)
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6/SL-6T)	100	(1)
	Livestock Exclusion with Riparian Buffers (LE-1T)	100	(1)
	Livestock Exclusion with Reduced Setback (LE-2/LE-2T)	100	(1)
	Small Acreage Grazing System (SL-6AT)	100	(1)
	Stream Protection/Fencing (WP-2/WP-2T)	100	(1)
Pasture	Manure Storage (WP-4)	80	VADCR, 2003
	Vegetative Cover on Critical Areas (SL-11)	75	VADCR, 2003
	Reforestation of Erodible Pasture (FR-1)	LU Conversion	N/A
	Woodland Buffer Filter Area (FR-3)	57	VADCR, 2003
	Pasture Management (EQIP 528, SL-10T)	50	USEPA-CBP, 2006
	Grazing Land Management (SL-9)	50	USEPA-CBP, 2006
	Wet Detention Pond for Pastureland	70	VADEQ, 2013
Cropland	Continuous No-Till (SL-15)	70	VADCR, 2003
	Small Grain Cover Crop (SL-8)	20	USEPA-CBP, 2006
	Permanent Vegetative Cover on Cropland (SL-1)	75	VADCR, 2003
	Sod Waterway (WP-3)	50	VADCR, 2003
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	50	VADCR, 2003
Residential			
Waste Treatment	Septic System Pump-Out (RB-1)	5	VADCR, 2003
	Sewer Connection (Targeted Areas and RB-2)	100	(1)
	Repaired Septic System (RB-3)	100	(1)
	Septic System Installation/Replacement (RB-4, RB-4P)	100	(1)
	Alternative Waste Treatment System Installation (RB-5)	100	(1)
Pet Waste	Pet Waste Composter	99	(1)
	Pet Waste Education Campaign	50	Swann, C., 1999
	Pet Waste Station	Included in Pet Waste Education Campaign	N/A
Urban			
Stormwater	Infiltration Trench	90	USEPA, 2014
	Bioretention	90	USEPA, 2014
	Rain Garden	70	Hunt, W.F., J.T. Smith, and J. Hathaway, 2007
	Constructed Wetland	80	VADEQ, 2013
	Manufactured BMP	80	USEPA-CBP, 2006
	Detention Pond	30	VADEQ, 2013
	Riparian Buffer: Forest	57	VADCR, 2003
	Riparian Buffer: Grass/Shrub	50	VADCR, 2003
Other	Stream Restoration	N/A	Stakeholder Input
	Stream Stabilization	N/A	VADCR, 2013

(1) Removal efficiency is defined by the practice. Once the practice/ system is installed, the source of bacteria is eliminated.

The BMP pollutant reduction efficiency values reported in Table 5-1 are averages and are subject to revision based on actual conditions present at the sites where each BMP is implemented. This is a planning level document and more accurate reduction efficiencies would be dependent on site conditions, BMP design and implementation. Additional information pertaining to stormwater BMPs can be found on the Virginia Stormwater BMP Clearinghouse (*http://www.vwrrc.vt.edu/swc/*) and the Virginia Stormwater Management Handbook (*http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications.aspx*) websites.

5.2 Quantification of Control Measures

The first step in the process to determine the number of each type of BMP was to identify existing BMPs and determine if they were established prior to 2008 or after 2008. Removal of pollutant loads of pre-2008 BMPs were already taken into account in the development of the 2008 bacteria TMDLs for Dan River, Birch Creek, and their tributaries. For most of the existing BMPs a date of installation was available. To account for pollutant reduction benefits from existing stormwater BMPs without installation dates, the pollutant reduction efficiencies were conservatively represented as 50% of the efficiency reported in Table 5-1.

Following identification of existing BMPs and the assessment of their pollutant removal capabilities, additional BMPs were recommended to achieve the TMDL pollutant reduction goals. The quantification procedures for proposed agricultural, residential, and urban land use BMPs are detailed in Sections 5.2.1 to 5.2.4. Specific locations for the proposed BMPs were not determined in this IP. Instead the approach proposed a specific suite of recommended BMPs based on land use (in the form of unit area pollutant loadings) and stakeholder input. Site-specific analysis is required prior to the siting, design, and implementation of the proposed BMPs.

The BMPs proposed in the following sections will address bacteria pollution in the Dan River and Birch Creek TMDL IP watershed. The BMPs were quantified to meet the bacteria and reductions called for in the TMDLs.

5.2.1 Agricultural Control Measures

This section depicts the BMPs associated with agricultural activities. It summarizes the existing and proposed livestock exclusion BMPs, pasture BMPs, and cropland BMPs for bacteria reductions.

Existing Agricultural BMPs

In the period between the development of the TMDL and this IP, agricultural BMPs have been implemented in all but three subwatersheds, Pumpkin Creek, Germy Creek, and Lawless Creek. Table 5-2 presents the BMPs implemented after the TMDL modeling period (post-TMDL development) and includes Harvestable Cover Crop/Small Grain Cover Crop for Nutrient Management (SL-8), Aforestation of Erodible Crop and Pastureland (FR-1), CREP Riparian Forest Buffer Planting (CRFR-3), Permanent Vegetative Cover on Critical Areas (SL-11), Livestock Exclusion with Reduced Setback (LE-2), and Stream Exclusion with Grazing Land Management (SL-6).

Proposed Livestock Exclusion and Pasture BMPs

The existing BMPs associated with livestock exclusion and pasture land are summarized in Section 5.2.1.1. Pollutant load reductions from the existing pasture and livestock exclusion BMPs were quantified and then subtracted from the pollutant load reductions called for in the TMDLs prior to proposing new BMPs.

Livestock exclusion BMPs proposed in this IP include CREP Livestock Exclusion (CRSL-6), Livestock Exclusion with Grazing Land Management (SL-6), Livestock Exclusion with Riparian Buffers (LE-1T), Small Acreage Grazing System (SL-6AT), Livestock Exclusion with Reduced Setback (LE-2/LE-2T), and Stream Protection/Fencing (WP-2/WP-2T). The overall length of all livestock exclusion systems proposed throughout the Dan River and Birch Creek watershed was determined using a geographic information system (GIS) spatial analysis of aerial imagery, land use (NLCD 2011), and National Hydrography Dataset stream layers as well as consultation with partners at the working group meetings. Based on feedback at the working group meetings that initial estimates seemed high, the original estimates for the Dan River watershed were reduced by 10%.

Table 5-2. Existing Agricultural BMPs

	Big Toby Creek		Birch Creek		Birch Creek, UT		Byrds Branch		Cane Creek		Cascade Creek	
BMP Type	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**
Aforestation of erodible crop and pastureland	9	11	28	28	27	27						
Alternative Water System												
Animal Mortality Incinerator												
Composter Facilities												
CREP Buffer Length Recording Practice												
CREP Grass filter strips												
CREP Grazing land protection	21,333	282										
CREP Riparian Forest Buffer Planting	36	36										
CREP Wildlife Habitat Buffer Rent												
Extension of CREP Watering Systems												
Fescue Conversion/Wildlife Option	17	17	14	14								
Field Borders/Wildlife Option			2	2								
Harvestable Cover Crop												
Idle Land/Wildlife Option and Idle Tobacco Land			21	21								
Long Term Continuous No-Till Planting System												
Long Term Vegetative Cover on Cropland									30	30	57	76
Nutrient Management Plan Implementation and Record Keeping												
Nutrient Management Plan Writing and Revisions												
Permanent vegetative cover on critical areas	4	15	3	3					1	1		
Protective cover for specialty crops	12	12	97	99	71	71	8	8				
Riparian Buffer Rent	36	36										
Septic Tank Pumpout					6	-						
Small Grain and Mixed Cover Crop for Nutrient Management and Residue Management											61	61
Sod waterway	1	8	3	94					3	44		
Stream Exclusion With Grazing Land Management	6,619	118	15,940	163	3,734	42	1,100	23			2,839	302
Streambank protection (fencing)			600	3								
Three Year Small Grain Cover Crop												
Total	28,067	534	16,707	426	3,838	139	1,108	31	34	75	2,957	439

Table 5-2. Existing Agricultural BMPs

	Powells Creek		Sandy Creek (east)		Sandy Creek (west)		Sandy River (north)		Miry Creek		Sandy River (south)		Tanyard Creek	
BMP Type	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**
Aforestation of erodible crop and pastureland	8	8	116	116			3	7	15	15	25	25		
Alternative Water System														
Animal Mortality Incinerator														
Composter Facilities									1	-				
CREP Buffer Length Recording Practice														
CREP Grass filter strips														
CREP Grazing land protection							6,150	271	5,698	95			1,588	2
CREP Riparian Forest Buffer Planting							15	15	5	5	10	10	2	2
CREP Wildlife Habitat Buffer Rent														
Extension of CREP Watering Systems									39	39				
Fescue Conversion/Wildlife Option														
Field Borders/Wildlife Option														
Harvestable Cover Crop					795	795	195	195					424	424
Idle Land/Wildlife Option and Idle Tobacco Land														
Long Term Continuous No-Till Planting System					362	362								
Long Term Vegetative Cover on Cropland			75	75	22	22	30	30	21	21	47	47		
Nutrient Management Plan Implementation and Record Keeping													435	435
Nutrient Management Plan Writing and Revisions													514	514
Permanent vegetative cover on critical areas			1	1			2	31						
Protective cover for specialty crops							8	8	19	19				
Riparian Buffer Rent							15	15	7	7	10	-	2	2
Septic Tank Pumpout									2	-				
Small Grain and Mixed Cover Crop for Nutrient Management and Residue Management					127	127	27	27					44	44
Sod waterway			2	11					0	3				
Stream Exclusion With Grazing Land Management			3,000	82	2,645	52	15,809	170	26,730	345	305	7	11,620	131
Streambank protection (fencing)														
Three Year Small Grain Cover Crop					62	74								
Total	8	8	3,194	285	4,012	1,431	22,255	770	32,537	547	397	89	14,629	1,555

Table 5-2. Existing Agricultural BMPs

	Dan River		Double Creek		Fall Creek		Lawsons Creek		Stewart Creek		Stokes Creek		Sugartree Creek	
BMP Type	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**	**Acres Benefitted**	**Acres Installed**
Aforestation of erodible crop and pastureland	53	53	15	25			12	13			10	10		
Alternative Water System	45	45												
Animal Mortality Incinerator							2	-						
Composter Facilities														
CREP Buffer Length Recording Practice					2,914	-								
CREP Grass filter strips					4	20								
CREP Grazing land protection	1,500	78												
CREP Riparian Forest Buffer Planting	27	27											0	0
CREP Wildlife Habitat Buffer Rent					4	4								
Extension of CREP Watering Systems	2	57												
Fescue Conversion/Wildlife Option	72	74					11	11						
Field Borders/Wildlife Option	4	4					8	8						
Harvestable Cover Crop														
Idle Land/Wildlife Option and Idle Tobacco Land	82	114									59	59		
Long Term Continuous No-Till Planting System														
Long Term Vegetative Cover on Cropland	11	11	45	45			8	8	9	9			13	13
Nutrient Management Plan Implementation and Record Keeping														
Nutrient Management Plan Writing and Revisions														
Permanent vegetative cover on critical areas	5	6	2	2			0	1						
Protective cover for specialty crops	479	479	250	250										
Riparian Buffer Rent	27	27											0	0
Septic Tank Pumpout														
Small Grain and Mixed Cover Crop for Nutrient Management and Residue Management	2,334	2,410												
Sod waterway					1	30								
Stream Exclusion With Grazing Land Management	40,993	583	5,781	191			6,942	123	7,457	120	10,220	108		
Streambank protection (fencing)														
Three Year Small Grain Cover Crop														
Total	45,631	3,966	6,093	513	2,923	54	6,983	165	7,466	129	10,289	178	14	14

Using data from the NLCD 2011 land use layer and the aerial imagery, the length of perennial and intermittent streams with and without adequate riparian buffer was analyzed for all obvious pasture areas. Next, a distribution percentage for each type of livestock exclusion BMP was determined based on guidance from Natural Resources Conservation Service (NRCS) and SWCD, with specific percentages identified for several subwatersheds. These percentages ranged from 10% for CREP Livestock Exclusion, 40% for Livestock Exclusion with Grazing Land Management, 5% for Livestock Exclusion with Reduced Setback, and 3% each for Small Acreage Grazing System and Stream Protection/Fencing. In each subwatershed, the length of each proposed BMP was calculated by multiplying the overall length of all proposed livestock exclusion systems (as described above) by the appropriate distribution percentage. This length was then divided by the average length (based on local practices as reported by the VADCR Agricultural BMP Database) of each livestock exclusion system BMP to arrive at the number of each type of livestock exclusion BMP proposed for each subwatershed (Table 5-3). The average length of each livestock exclusion system was calculated from the average lengths of the existing systems within the Dan River watershed.

Example of Livestock Exclusion

(Photograph courtesy of USFWS)

Table 5-3. Livestock Exclusion BMPs (feet)						
	CREP Livestock Exclusion (CRSL-6)	**Livestock Exclusion for TMDL IP (LE-1T)**	**Livestock Exclusion for TMDL IP (SL-6)**	**Small Acreage Grazing System (SL-6A)**	**Livestock Exclusion with Reduced Setback (LE-2T)**	**Stream Protection/Fencing (WP-2T)**
Dan River	35,666	140,882	140,882	10,700	17,833	10,700
Miry Creek	1,854	7,325	7,325	556	927	556
Birch Creek	855	3,376	3,376	256	427	256
Birch Creek UT	220	870	870	66	110	66
Germy Creek	20	80	80	6	10	6
Big Toby Creek	1,650	6,519	6,519	495	825	495
Fall Creek	683	2,700	2,700	205	342	205
Lawless Creek	37	145	145	11	18	11
Sandy Creek (west)	2,327	9 ,191	9,191	698	1,163	698
Sandy River (south)	3,023	1 1,939	11,939	907	1,511	907
Stewart Creek	798	3 ,153	3,153	239	399	239
Sugartree Creek	674	2 ,661	2,661	202	337	202
Sandy River (north)	2,905	11,477	11,477	872	1,453	872
Tanyard Creek	1,484	5 ,861	5,861	445	742	445
Cascade Creek	2,210	8,730	8,730	663	1,105	663
Stokes Creek	343	1,355	1,355	103	172	103
Lawson's Creek	2,561	10,118	10,118	768	1,281	768
Powell's Creek	771	3,044	3,044	231	385	231
Byrd's Branch	69	272	272	21	34	21
Double Creek	512	2,024	2,024	154	256	154
Sandy Creek (east)	303	1,196	1,196	91	151	91
Cane Creek	1,266	5,001	5,001	380	633	380
Pumpkin Creek	122	483	483	37	61	37

The quantification of acres installed for the proposed pasture BMPs (Table 5-4) was based on the area of pasture located within each subwatershed and the pollutant reductions required from this land use. After taking account of the reductions provided by existing BMPs, Vegetative cover on critical areas was proposed for up to 65% of pastureland in Dan River, Cane Creek, Cascade Creek, Pumpkin Creek, Sandy Creek East, Powell's Creek, Fall Creek, Lawless Creek, Sandy River South, Sandy Creek West, Stewart Creek, Birch Creek, and Germy Creek. Reforestation of erodible pasture was proposed for up to 30% of pastureland in these watersheds as well. Woodland Buffer Filter area was proposed for 5-10% of pastureland. Then, pasture management was applied to the remaining unconverted land. Wet detention ponds, Animal Waste Control Facility (WP-4), and stream restoration, quantified as acres treated, were proposed if the necessary pollutant reductions on pasture land use could not be accomplished through the other BMPs. The varying percentages reflect the bacteria reductions required. The remaining watersheds needed less (1-10% of pastureland in SL-11 and FR-1) to meet the TMDL.

Table 5-4. Proposed Pastureland BMPs (acres-installed)							
	Manure Storage (WP-4)	Woodland buffer filter area (FR-3)	Vegetative Cover on Critical Areas (SL-11)	Reforestation of Erodible Pasture (FR-1)	Pasture Management (EQIP 528, SL-10T)	Wet Detention Ponds*	Grazing Land Management (SL-9)
Dan River	75	2,900	37,701	11,600	4,640	5,000	500
Miry Creek	-	70	70	71	702	-	10
Birch Creek	-	223	558	228	335	-	-
Birch Creek UT	-	16	82	17	16	-	25
Germy Creek	1	40	515	198	79	192	100
Big Toby Creek	1	41	41	41	41	10	10
Fall Creek	10	258	3,431	1,290	516	1,500	300
Lawless Creek	3	120	807	310	124	337	50
Sandy Creek (west)	-	748	4,863	831	748	50	-
Sandy River (south)	15	412	5,355	2,392	1,236	1,850	475
Stewart Creek	7	381	2,476	423	381	1,025	300
Sugartree Creek	3	82	1,066	410	164	500	100
Sandy River (north)	1	98	490	99	490	10	10
Tanyard Creek	-	177	2,111	187	355	-	-
Cascade Creek	2	55	2,214	2,372	553	150	100
Stokes Creek	-	36	36	36	36	-	-
Lawson's Creek	-	74	74	75	74	-	10
Powell's Creek	3	63	819	315	126	300	100
Byrd's Branch	-	6	6	6	31	-	-
Double Creek	1	36	36	36	36	-	10
Sandy Creek (east)	-	42	718	469	633	-	-
Cane Creek	8	387	2,516	1,659	503	500	400
Pumpkin Creek	1	24	316	121	49	75	50
*acres treated							

Cropland BMPs (Existing/Proposed)

Cropland BMPs reported in the DCR Agricultural BMP Database are present in some of the subwatersheds (Table 5-2). The bacteria reductions resulting from the post-TMDL development BMPs were calculated using the acreage in which the practice was installed, the amount of pollutant produced by each acre, and the pollutant reduction efficiency of the BMP.

The amount of cropland in each watershed (based on NLCD 2011) was small. The acres installed for each proposed cropland BMPs (Table 5-5) was based on the amount of cropland located within each subwatershed and the pollutant reductions required from this land use. Permanent vegetative cover on cropland (SL-1), in conjunction with Small Grain Cover Crop BMPs, were the primary BMPs proposed for pollutant reductions from cropland. If the pollutant load reductions could not be met from these BMPs, other cropland BMPs were proposed on 2-

15% of cropland acres: Vegetative Cover on Critical Areas (SL-11), Reforestation of Erodible Pasture (FR-1), Sod Waterway, and Cropland Buffer/Field Borders.

For some watersheds, the necessary reductions from cropland are being met by existing cropland BMPs put in place since the development of the TMDL. In these watersheds (Cascade Creek, Double Creek, Sandy River North, Sandy Creek West, Sugartree Creek, and Tanyard Creek), a small amount of coverage is proposed for each appropriate BMP. Table 5-5 presents the proposed cropland BMPs for each subwatershed.

Table 5-5. Proposed Cropland BMPs (acres-installed)

	Continuous No-Till (SL-15)	Small Grain Cover Crop (SL-8)	Permanent Vegetative Cover on Cropland (SL-1)	Sod Waterway (WP-3)	Cropland Buffer/Field Borders (CP-33 and WQ-1)	Vegetative Cover on Critical Areas (SL-11)	Reforestation of Erodible Pasture (FR-1)
Dan River	6	13	114	8	8	8	114
Miry Creek	6	7	6	1	1	1	6
Birch Creek	23	24	50	8	8	8	53
Birch Creek UT	0	0	0	0	0	0	0
Germy Creek	8	8	10	1	1	1	9
Big Toby Creek	8	9	36	2	2	2	40
Fall Creek	14	15	17	2	2	2	17
Lawless Creek	1	0	25	1	1	2	25
Sandy Creek (west)	17	17	11	4	4	4	12
Sandy River (south)	24	24	24	2	2	2	21
Stewart Creek	12	11	10	2	2	2	10
Sugartree Creek	1	1	1	1	1	1	1
Sandy River (north)	3	3	1	1	1	1	1
Tanyard Creek	2	2	2	1	1	1	2
Cascade Creek	1	6	3	1	1	3	1
Stokes Creek	22	5	13	1	1	1	13
Lawson's Creek	7	18	28	2	2	5	28
Powell's Creek	2	2	2	0	0	0	2
Byrd's Branch	9	6	1	1	1	1	1
Double Creek	5	5	1	1	1	1	1
Sandy Creek (east)	1	2	4	1	1	1	4
Cane Creek	39	6	28	2	2	2	28
Pumpkin Creek	0	7	5	0	0	0	5

5.2.2 Residential Bacteria Control Measures

Failing Septic Systems, Straight Pipes, Sewer Connections

Western VA Water Authority Sewerline Connection
(Photograph courtesy of WVWA)

BMPs available to address failing septic and sewer systems consist of septic system pump-outs (RB-1), sewer connections (targeted areas and RB-2), septic system repairs (RB-3), septic system installation or replacement (RB-4, RB-4P), and alternative waste treatment system installation (RB-5). Quantification of existing residential sewage disposal methods was based on a spatial analysis using data on the buildings in each subwatershed, the extent of the sewer system, the stream network, and the application of a variable percentage of failing septic systems (including straight pipes). The spatial data provided by the City of Danville was used to determine whether a building was on septic or sewer.

The quantification of the proposed residential waste treatment BMPs used the estimated numbers of existing houses on sewer, septic, and straight pipes as well as the estimated number of failing septic systems. The percentage of failing septic systems was estimated as 3% of existing septic systems (VADEQ, 2006a). Ten percent of the total existing number of households on septic systems are proposed to be pumped out (RB-1). The number of proposed residential waste treatment systems was calculated using implementation percentages derived from distribution percentages used in other published implementation plans (VADEQ, 2016), and stakeholder consensus of likely practices in the watersheds. These percentages were then applied to the estimated number of failing septic systems in each subwatershed. In summary, 60% of failing septic systems were proposed for septic repair (RB-3), 25% for septic install/replace (RB-4, RB-4P), and 15% for alternative waste treatment systems (RB-5). Corrections to straight pipes are included under the septic install/replace category (RB-4, RB-4P).

Quantification of sewer connection (RB-2) as a BMP was based on consultation with stakeholders and an assessment of locations for which sewer connections would be feasible. Connection to sewer is only proposed in five subwatersheds. Most of the subwatersheds are too rural for any sewer connections and do not have existing sewer systems within the subwatersheds that would allow potential expansion. In the subwatersheds that do have existing sewer systems, stakeholders indicated that the sewer treatment plant(s) that service these areas are at capacity. This affected the number of sewer connections proposed in the IP.

Table 5-6 details the number of septic system pump-outs, sewer connections, septic system repairs, new septic systems (install/replace), and alternative waste treatment systems for each subwatershed.

Table 5-6. Proposed Sewage Disposal BMPs

	Total Septic Pumpout (RB-1)	Sewer Connection (Target Areas and RB-2)	Total Septic Repair (RB-3)	Total Septic Install /Replace (RB-4)	Total Alternative Waste Treatment System (RB-5)	Total
Dan River	1,014	208	225	187	95	1,730
Miry Creek	49	0	9	7	2	67
Birch Creek	126	0	23	14	6	168
Birch Creek UT	12	0	2	1	1	16
Germy Creek	13	0	2	1	1	17
Big Toby Creek	28	0	5	3	1	37
Fall Creek	127	0	23	25	6	180
Lawless Creek	12	0	2	2	1	16
Sandy Creek (west)	142	115	49	45	34	385
Sandy River (south)	156	44	35	33	15	283
Stewart Creek	30	0	7	6	3	46
Sugartree Creek	17	0	4	4	2	26
Sandy River (north)	136	0	25	15	6	182
Tanyard Creek	100	0	18	12	5	134
Cascade Creek	146	0	26	16	7	195
Stokes Creek	22	0	4	3	1	29
Lawson's Creek	45	0	8	5	2	60
Powell's Creek	17	0	3	2	1	23
Byrd's Branch	5	0	1	0	0	6
Double Creek	41	0	7	4	2	54
Sandy Creek (east)	64	0	11	7	3	85
Cane Creek	75	66	14	13	3	171
Pumpkin Creek	106	119	44	64	33	366

Pet Waste Reduction

Pet Waste Station
(Photograph courtesy of Scoopmasters.com)

BMPs that are proposed to reduce pet waste include pet waste stations, pet waste composters, and pet waste education campaigns.

Pet waste composters are in-ground pet waste disposal systems that function similar to a household septic system. Pet waste composters are most appropriate for pet owners that have small lots and live in an urban area with limited outdoor space for pets. The unit requires the addition of water and a digester enzyme mixture to break down dog waste into a liquid that is released to and absorbed by the underlying soil. Pet waste composters were proposed for 5% of pet-owning households. The bacteria reduction efficiency for composters was added to the pet waste education campaign reduction efficiency.

Typical pet waste stations include pet waste trash bags, bag dispenser, a steel trashcan for waste disposal, and signage directing citizens about the importance of picking up after pets. The pet waste stations proposed in this IP include a supply of bag refills for a five-year period. Pet waste disposal stations should be placed in locations where there is the likelihood of pet presence. Stakeholders recommended pet waste stations at parks, trails, buildings (e.g., apartments, hotels, and restaurants), neighborhoods, and other developed sites. Appropriate areas for pet waste stations were determined through GIS analysis and stakeholder suggestions.

Lastly, it was assumed that one pet waste education campaign per subwatershed would be appropriate and feasible. The campaigns will include installation of signage in residential areas reminding citizens to pick up after their pets because of the water quality issues in the watershed, flyers mailed to residents explaining the detrimental effects of not picking up after pets, targeted campaigns at veterinarian clinics and kennels, and outreach through animal control officers and parks and recreational staff. Table 5-7 details the number of pet waste education campaigns, and proposed pet waste stations and pet waste composters for each subwatershed.

Table 5-7. Proposed Pet Waste BMPs (units)			
	Pet Waste Composters	**Pet Waste Stations**	**Pet Waste Educational Campaign**
Dan River	176	39	1
Miry Creek	9		1
Birch Creek	23		1
Birch Creek UT	2		1
Germy Creek	2		1
Big Toby Creek	5		1
Powell's Creek	3		1
Byrd's Branch	1		1
Double Creek	7		1
Sandy Creek (east)	12	1	1
Cane Creek	14	1	1
Pumpkin Creek	14	2	1
Fall Creek	23	1	1
Lawless Creek	2		1
Sandy Creek (west)	21		1
Sandy River (south)	27	3	1
Stewart Creek	5		1
Sugartree Creek	3		1
Sandy River (north)	25		1
Tanyard Creek	18		1
Cascade Creek	27		1
Lawson's Creek	8		1
Stokes creek	4		1
Total	**430**	**47**	**23**

5.2.3 Urban Control Measures (Existing and Proposed)

Stormwater

When it rains, runoff from impervious surfaces, i.e., roads, parking lots, and sidewalks, picks up pollutants such as bacteria and sediment along the way. In addition, impervious surfaces lead to increases in the velocity of water entering streams, which increases stream erosion. Stormwater BMPs consist of practices that mitigate these impacts by filtering and storing stormwater runoff before it reaches surface waters. Some BMPs such as rain gardens work on a small scale whereas others such as detention ponds and constructed wetlands filter stormwater from larger areas. This IP proposes a wide selection of stormwater BMPs that range from low-impact development (LID) techniques, which mimic natural hydrology by allowing rainwater to

infiltrate/filter/evaporate at the source, and more traditional BMP techniques which channel and pipe stormwater to large scale holding areas.

Existing Stormwater BMPs

The City of Danville provided stormwater BMP information for inclusion in this IP. Based on these data, there are approximately 66 existing stormwater management BMPs within the Birch Creek and Dan River TMDL IP watersheds that drain approximately 262 acres (Table 5-8). These BMPs include detention ponds, rain gardens, manufactured BMPs, and grass swales.

Bioretention Area, Wetland Studies and Solutions, Inc., Virginia

Reductions in bacteria loads due to the existing BMPs were calculated and taken into account during quantification of new proposed BMPs. Most stormwater BMPs indicated a date of installation, but some did not. In order to account for some benefit from existing stormwater BMPs without an installation date, reductions from these existing BMPs were accounted for in the IP by reducing their pollutant reduction efficiencies by 50%.

Table 5-8. Existing Stormwater BMP Summary								
	Units	Cane Creek	Dan River	Fall Creek	Pumpkin Creek	Sandy Creek (west)	Sandy River (south)	Total
Bioretention	count		2					2
	acres treated		5					5
Detention	count	1	6	3	1	3		14
	acres treated	3	45	10	1	4		62
Dry Swale	count		2					2
	acres treated		0.3					0.3
Extended Detention	count		2	2			2	6
	acres treated		7	12			2	22
Manufactured BMPs (includes Filterra)	count		18			4		22
	acres treated		95			6		100
Grass Swale	count		1					1
	acres treated		5					5
Infiltration Trench	count		1		4			5
	acres treated		3		29			31
Rain Garden	count		6				1	7
	acres treated		24				2	26
Undreground Detention	count	1	3	1	1	1		7
	acres treated	2	4	1	1	3		11

Proposed Stormwater BMPs

Proposed stormwater BMPs include bioretention basins, rain gardens, infiltration basin/trenches, manufactured BMPs[1], constructed wetlands, detention ponds, vegetated swales, and riparian buffers (forested or grass/shrub) (Table 5-9). Some stormwater BMPs function better when placed on particular soil types. Infiltration basins or trenches are better on well-draining soil, whereas bioretention basins, manufactured BMPs, and constructed wetlands work better on poorly draining soil. Because of area and size constraints, BMPs on dense urban landscapes typically include bioretention and manufactured BMPs.

A variety of methods were applied for the quantification of stormwater BMPs. The stormwater BMPs are proposed on the available developed land within the watershed. In general, the strategy was to evenly increase the number of stormwater BMPs until the needed bacteria

[1] Manufactured BMPs or manufactured treatment devices (also referred to as *proprietary treatment devices*) means commercial products fabricated in manufacturing facilities that provide stormwater pollution treatment. Some examples include hydrodynamic separators and filters. (Source: VA Stormwater BMP Clearinghouse).

reduction was met. Table 5-9 presents the proposed drainage area for each stormwater BMP by watershed.

Quantification of the appropriate length of urban riparian buffer required spatial analysis of aerial imagery, land use, and stream layers using GIS. Stream layers located within urban land uses were evaluated and the lengths of perennial and intermittent streams that were lacking adequate riparian buffer were noted. In addition, the analysis noted whether the riparian buffer was needed on one or both sides of the stream. An average urban riparian buffer of 100 feet was used to calculate the maximum total acreage of proposed buffers. This average buffer width was used in lieu of site-specific riparian buffer widths. However, riparian buffers naturally vary in width and narrower riparian buffers can still provide stream bank stabilization and result in instream water quality benefits. Therefore, a riparian buffer of 25 feet was used to calculate the minimum total acreage of proposed buffer. Site-specific analysis is required prior to the siting, design, and implementation of this BMP to determine the appropriate width and type for each location. After summing the total length of stream (either on one side or both) and multiplying it by 25 feet and 100 feet, the minimum and maximum total acreage was determined and then split evenly between the forested and grass/shrub buffer types. Streams that appeared to be associated with a stormwater detention pond or retention area were not included nor were streams that flowed through residential or other developed areas where the addition of riparian buffer would not be feasible. Table 5-9 presents the proposed urban riparian buffer length for each watershed.

Table 5-9. Proposed Stormwater BMPs (acres-treated)								
	Bioretention	Rain garden	Infiltration Trench	Manufactured BMP	Constructed Wetland	Detention Pond	Riparian Buffer (Forested)	Riparian Buffer (Grass/Shrub)
Dan River	2,000	2,000	2,000	1,500	1,900	1,500	82	82
Miry Creek	100	100	100	80	100	50	1	1
Birch Creek	275	275	50	20	120	10	2	2
Birch Creek UT	20	12	10	11	16	6	-	-
Germy Creek	25	15	9	10	10	11	-	-
Big Toby Creek	50	28	25	26	2	-	0	0
Fall Creek	550	550	250	250	550	100	10	10
Lawless Creek	52	25	25	25	50	50	0	0
Sandy Creek (west)	350	350	250	250	258	230	5	5
Sandy River (south)	400	400	250	250	225	200	3	3
Stewart Creek	125	125	20	20	25	-	0	0
Sugartree Creek	35	35	35	30	30	20	1	1
Sandy River (north)	110	100	100	100	100	100	0	0
Tanyard Creek	30	30	10	10	30	17	0	0
Cascade Creek	75	75	60	30	70	20	2	2
Stokes Creek	100	58	50	50	55	50	1	1
Lawson's Creek	150	150	50	150	150	145	1	1
Powell's Creek	30	16	19	17	20	21	1	1
Byrd's Branch	10	10	10	9	6	4	-	-
Double Creek	25	25	22	22	24	-	0	0
Sandy Creek (east)	100	100	50	50	75	50	0	0
Cane Creek	200	200	200	100	100	125	2	2
Pumpkin Creek	300	225	200	200	210	150	19	19

5.2.4 Stream Restoration

Stream restoration projects are those that use instream engineering methods and/or natural stream design techniques to protect and restore the stream and associated hydrology and enhance riparian plant communities, which will reduce erosion and sediment transport. Stream stabilization projects are those that use vegetation and/or harder materials to stabilize and protect the streambanks. Stakeholders within the Birch Creek and Dan River TMDL watersheds have expressed an interest in including stream restoration and stream stabilization as part of this IP. In the Dan River subwatershed 100 linear feet of stream restoration and stabilization are proposed. Twenty feet of each are proposed in the remaining subwatersheds.

5.3 Technical Assistance

Technical assistance will be necessary beyond what local programs and services provide to help the stakeholders implement agricultural, residential, and stormwater BMPs proposed in this IP. Technical assistance includes (1) performing administrative and organizational tasks, (2)

providing outreach and education about BMPs and available funding, and (3) assisting with the design and installation of BMPs. Quantification of technical assistance is in Full Time Equivalents (FTEs). Technical assistance for agricultural BMPs would be provided through the Halifax Soil and Water Conservation District (SWCD) and Pittsylvania SWCD. Technical assistance for residential BMPs could possibly be provided through SWCDs, health departments, regional planning commission or county governments, dependent upon available grant funding. In addition, there will be a need for technical assistance for stormwater BMP implementation, which could be handled through a regional planning commission or county governments. Below are lists of potential activities associated with technical assistance by program type.

- **Potential technical assistance and educational outreach tasks associated with agricultural programs**

  1. Make contacts with landowners in the watershed to make them aware of implementation goals and cost-share assistance programs.
  2. Provide technical assistance for agricultural programs (e.g., survey, design, layout, and approval of BMP installation).
  3. Administer cost-share assistance and track BMP implementation.
  4. Develop educational materials and programs, based on local needs.
  5. Organize educational programs (e.g., pasture walks, presentations at field days or grazing-club events, etc.).
  6. Distribute educational materials (e.g., informational articles in Farm Service Agency [FSA] or Farm Bureau newsletters, local media, etc.).
  7. Assess progress towards BMP implementation goals.
  8. Follow-up contact with landowners who have installed BMPs.
  9. Coordinate use of existing agricultural programs and suggest modifications where necessary.

- **Potential technical assistance and educational outreach tasks associated with residential programs**

1. Make contacts with landowners in targeted areas where there are documented problems with on-site sewage systems based on age of homes, poor soils, and high number of repairs and replacements of systems needed based on IP data.
2. Track septic system repairs/ replacements / installations.
3. Administer cost-share assistance and track BMP implementation.
4. Develop educational materials and programs.
5. Organize educational programs (e.g., demonstration of septic pump-outs).
6. Distribute educational materials (e.g., informational pamphlets on TMDLs, and on-site sewage disposal systems).
7. Assess progress toward BMP implementation goals.
8. Follow-up contact with landowners who have participated in the program(s).

- **Potential technical assistance and educational outreach tasks associated with stormwater BMP implementation**
  1. Make contacts with landowners in the local watersheds to make them aware of implementation goals.
  2. Assist in the identification of grant opportunities and development of grant writing to fund BMP implementation.
  3. Provide assistance for stormwater BMPs (e.g., survey, design, layout, and approval of installation).
  4. Develop educational materials and local workshops on rain barrels, rain gardens, vegetated buffers, turf to trees, etc.
  5. Organize and distribute educational programs.
  6. Assess and track progress toward BMP implementation goals.
  7. Follow-up contact with landowners who have installed BMPs.

As stated previously, the BMPs proposed in this plan would be implemented over the course of a 15 or 20 year timeline depending on the subwatershed. BMP numbers by watershed vary and are staggered across the timeline; this approach includes implementation of the more cost-effective

BMPs in the earlier stages, and the more costly or challenging BMPs in the later stages. The technical assistance proposed in this plan reflects the differences in BMP implementation goals across the staged timeline and experiences from TMDL watershed implementation projects statewide. Chapter 6, Section 6.1 will describe the staging of the BMPs in greater detail for each subwatershed.

A total of 2 FTEs for agricultural BMPs are proposed per year for the first stage, one FTE per year for the second stage, and 0.5 FTE per year for the third stage. Two FTEs would be necessary for implementation of residential waste treatment BMPs for the first and second stages, and one for the final stage. FTEs for non-MS4 stormwater BMPs would apply to urban areas that are outside of MS4 boundaries (Table 5-10).

Table 5-10. Full Time Equivalent Positions by IP Stage and BMP Category

	Stage 1 (Year 1-6)	Stage 2 (Year 7-12)	Stage 3 (Year 13-15)
Agricultural	2	1	0.5
Residential	2	1	1
Non-MS4 Urban	0.5	0.5	0.25

5.4 Costs of Control Measures

The costs for the control measures were derived from multiple sources. Table 5-14 shows the cost of each BMP per system/unit/program, per acre installed, or acre treated, as well as the cost sources. Costs in Table 5-14 and subsequent tables are based on BMP installation and do not include maintenance, unless otherwise noted. Maintenance costs are recognized as an added expense in implementing BMPs; they vary widely across all source sectors addressed by the TMDL IP: agriculture, onsite sewage systems, streambank stabilization and restoration, and stormwater.

Tables 5-12 to 5-34 present the total costs of IP actions for all three implementation stages by subwatershed, grouped by BMP category and type; these costs do not include costs associated with technical assistance. Tables 5-35 depicts the costs associated with technical assistance,

which transcends watershed boundaries. Table 5-36 summarizes the cost for all subwatersheds to attain the bacteria TMDL allocations set in the individual TMDLs, as described in Chapter 3.

Table 5-11. Best Management Practice Cost

Agricultural			
BMP Type	**BMP**	**Cost (per foot or acre)**	**Reference**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	VADCR. 2013
	Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6/SL-6T)	$8.79	Stakeholder Input, modified to show cost on a per foot basis
	Livestock Exclusion with Riparian Buffers (LE-1T)	$8.79	Stakeholder Input, modified to show cost on a per foot basis
	Livestock Exclusion with Reduced Setback (LE-2/LE-2T)	$5.98	VADEQ, 2012
	Small Acreage Grazing System (SL-6AT)	$3.16	VADEQ, 2012
	Stream Protection/Fencing (WP-2/WP-2T)	$7.38	VADCR. 2013
Pasture	Manure Storage (WP-4) - Beef	$58,000 /system	VADCR. 2013
	Vegetative Cover on Critical Areas (SL-11)	$2500	Stakeholder Input
	Reforestation of Erodible Pasture (FR-1)	$200	Stakeholder Input
	Woodland Buffer Filter Area (FR-3)	$700	VADCR. 2013
	Pasture Management (EQIP 528, SL-10T)	$75	VADCR. 2013
	Grazing Land Management (SL-9)	$200	VADCR. 2013
	Wet Detention Pond for Pastureland	$150	VADEQ, 2012
Cropland	Continuous No-Till (SL-15)	$100	9
	Small Grain Cover Crop (SL-8)	$30	VADCR. 2013
	Permanent Vegetative Cover on Cropland (SL-1)	$175	VADCR. 2013
	Sod Waterway (WP-3)	$2500	Stakeholder Input
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	VADCR. 2013
Residential			
BMP Type	**BMP**	**Cost (per system or program)**	**Reference**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	Stakeholder Input
	Sewer Connection (Targeted Areas and RB-2)	$11,000	Stakeholder Input
	Repaired Septic System (RB-3)	$5,000	Stakeholder Input
	Septic System Installation/Replacement (RB-4, RB-4P)	$8,000	VADCR. 2013
	Alternative Waste Treatment System Installation (RB-5)	$16,000	VADCR. 2013
Pet Waste	Pet Waste Education Campaign (program)	$5,000	VADEQ, 2013
	Pet Waste Composter	$90	Doggie Dooley, 2018
	Pet Waste Station	$300	Stakeholder Input
Urban			
BMP Type	**BMP**	**Cost (per acre-treated)**	**Reference**
Stormwater	Infiltration Trench	$6,000	VADEQ, 2011
	Bioretention	$10,000	VADCR, 2006
	Rain Garden	$5,000	VADCR, 2006
	Constructed Wetland	$2,900	Schueler et al., 2007
	Manufactured BMP	$20,000	VADCR, 2013
	Detention Pond	$3,800	Schueler et al., 2007
	Riparian Buffer: Forest	$3,500	Rivanna River Basin Commission. 2012
	Riparian Buffer: Grass/Shrub	$360	VADCR, 2006
	Stream Restoration	$300 per linear foot	VADEQ. 2016
	Stream Stabilization	$75 per linear foot	VADEQ. 2016
	Stream Stabilization	$75 per linear foot	Stakeholder Input

Table 5-12. Dan River Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	35,666	$338,484
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	140,882	$1,237,975
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	140,882	$1,237,975
	Small Acreage Grazing System (SL-6AT)	$3.16	10,700	$33,848
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	17,833	$106,560
	Stream Protection/Fencing (WP-2T)	$7.38	10,700	$78,980
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	75	$4,350,000
	Woodland buffer filter area (FR-3)	$700	2,900	$2,030,070
	Vegetative Cover on Critical Areas (SL-11)	$2,500	37,701	$94,253,090
	Reforestation of Erodible Pasture (FR-1)	$200	11,600	$2,320,080
	Pasture Management (EQIP 528, SL-10T)	$75	4,640	$348,010
	Wet Detention Ponds (acre-treated)	$150	5,000	$750,000
	Grazing Land Management (SL-9)	$200	500	$100,000
Cropland	Continuous No-Till (SL-15)	$100	6	$630
	Small Grain Cover Crop (SL-8)	$30	13	$390
	Permanent Vegetative Cover on Cropland (SL-1)	$175	114	$19,990
	Sod Waterway (WP-3)	$2,500	8	$19,040
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	8	$7,620
	Vegetative Cover on Critical Areas (SL-11)	$2,500	8	$19,040
	Reforestation of Erodible Pasture (FR-1)	$200	114	$22,850
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	1,014	$202,809
	Sewer Connection (Targeted Areas and RB-2)	$11,000	208	$2,288,000
	Repaired Septic System (RB-3)	$5,000	225	$1,127,000
	Septic System Installation/Replacement (RB-4)	$8,000	187	$1,498,000
	Alternative Waste Treatment System (RB-5)	$16,000	95	$1,525,600
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	39	$11,700
	Pet waste Composter	$90	176	$15,802
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	2,000	$20,000,000
	Rain Gardens	$5,000	2,000	$10,000,000
	Infiltration Trench	$6,000	2,000	$12,000,000
	Manufactured BMP	$20,000	1,500	$30,000,000
	Constructed Wetland	$2,900	1,900	$5,510,000
	Detention Pond	$3,800	1,500	$5,700,000
	Riparian Buffer: Forest (acre-installed)	$3,500	82	$286,010
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	82	$29,420
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	100	$30,000
Stream Stabilization		$75	100	$7,500
			Total Subwatershed IP Cost	**$197,511,473**

Table 5-13. Big Toby Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	1,650	$15,662
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	6,519	$57,281
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	6,519	$57,281
	Small Acreage Grazing System (SL-6AT)	$3.16	495	$1,566
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	825	$4,931
	Stream Protection/Fencing (WP-2T)	$7.38	495	$3,654
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	1	$58,000
	Woodland buffer filter area (FR-3)	$700	41	$28,520
	Vegetative Cover on Critical Areas (SL-11)	$2,500	41	$101,860
	Reforestation of Erodible Pasture (FR-1)	$200	41	$8,230
	Pasture Management (EQIP 528, SL-10T)	$75	41	$3,060
	Wet Detention Ponds (acre-treated)	$150	10	$1,500
	Grazing Land Management (SL-9)	$200	10	$2,000
Cropland	Continuous No-Till (SL-15)	$100	8	$810
	Small Grain Cover Crop (SL-8)	$30	9	$270
	Permanent Vegetative Cover on Cropland (SL-1)	$175	36	$6,340
	Sod Waterway (WP-3)	$2,500	2	$4,030
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	2	$1,610
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2	$4,030
	Reforestation of Erodible Pasture (FR-1)	$200	40	$8,050
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	28	$5,570
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	5	$24,000
	Septic System Installation/Replacement (RB-4)	$8,000	3	$24,000
	Alternative Waste Treatment System (RB-5)	$16,000	1	$19,200
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	5	$460
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	50	$500,000
	Rain Gardens	$5,000	28	$140,000
	Infiltration Trench	$6,000	25	$150,000
	Manufactured BMP	$20,000	26	$510,000
	Constructed Wetland	$2,900	2	$5,800
	Detention Pond	$3,800	0	$0
	Riparian Buffer: Forest (acre-installed)	$3,500	0.12	$420
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0.12	$40
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$1,760,674**

Table 5-14. Cane Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	1,266	$12,016
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	5,001	$43,947
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	5,001	$43,947
	Small Acreage Grazing System (SL-6AT)	$3.16	380	$1,202
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	633	$3,783
	Stream Protection/Fencing (WP-2T)	$7.38	380	$2,804
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	7.5	$435,000
	Woodland buffer filter area (FR-3)	$700	387	$270,950
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2516	$6,289,800
	Reforestation of Erodible Pasture (FR-1)	$200	1659	$331,770
	Pasture Management (EQIP 528, SL-10T)	$75	503	$37,740
	Wet Detention Ponds	$150	500	$75,000
	Grazing Land Management (SL-9)	$200	400	$80,000
Cropland	Continuous No-Till (SL-15)	$100	39	$3,950
	Small Grain Cover Crop (SL-8)	$30	6	$180
	Permanent Vegetative Cover on Cropland (SL-1)	$175	28	$4,870
	Sod Waterway (WP-3)	$2,500	2	$5,560
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	2	$2,220
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2	$5,560
	Reforestation of Erodible Pasture (FR-1)	$200	28	$5,560
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	92	$18,340
	Sewer Connection (RB-2)	$11,000	66	$726,000
	Repaired Septic System (RB-3)	$5,000	30	$151,500
	Septic System Installation/Replacement (RB-4)	$8,000	29	$234,000
	Alternative Waste Treatment System	$16,000	20	$319,200
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	1	$300
	Pet Waste Composter	$90	14	$1,240
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	200	$2,000,000
	Rain Gardens	$5,000	200	$1,000,000
	Infiltration Trench	$6,000	200	$1,200,000
	Manufactured BMP	$20,000	100	$2,000,000
	Constructed Wetland	$2,900	100	$290,000
	Detention Pond	$3,800	125	$475,000
	Riparian Buffer: Forest (acre-installed)	$3,500	2	$7,550
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	2	$780
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$16,092,270**

Table 5-15. Cascade Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	2,210	$20,970
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	8,730	$76,710
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	8,730	$76,710
	Small Acreage Grazing System (SL-6A)	$3.16	663	$2,100
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	1,105	$6,600
	Stream Protection/Fencing (WP-2T)	$7.38	663	$4,890
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	**$58,000**	**2.15**	$124,700
	Woodland buffer filter area (FR-3)	$700	55	$38,740
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2,214	$5,534,250
	Reforestation of Erodible Pasture (FR-1)	$200	2,372	$474,360
	Pasture Management (EQIP 528, SL-10T)	$75	553	$41,510
	Wet Detention Ponds	$150	150	$22,500
	Grazing Land Management (SL-9)	$200	100	$20,000
Cropland	Continuous No-Till (SL-15)	$100	1	$70
	Small Grain Cover Crop (SL-8)	$30	6	$170
	Permanent Vegetative Cover on Cropland (SL-1)	$175	3	$590
	Sod Waterway (WP-3)	$2,500	1	$1,680
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$670
	Vegetative Cover on Critical Areas (SL-11)	$2,500	3	$8,420
	Reforestation of Erodible Pasture (FR-1)	$200	1	$130
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	146	$29,210
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	26	$132,000
	Septic System Installation/Replacement (RB-4)	$8,000	16	$128,000
	Alternative Waste Treatment System (RB-5)	$16,000	7	$105,600
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	27	$2,400
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	75	$750,000
	Rain Gardens	$5,000	75	$375,000
	Infiltration Trench	$6,000	60	$360,000
	Manufactured BMP	$20,000	30	$600,000
	Constructed Wetland	$2,900	70	$203,000
	Detention Pond	$3,800	20	$76,000
	Riparian Buffer: Forest (acre-installed)	$3,500	2	$5,990
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	2	$620
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$9,236,090**

Table 5-16. Lawson's Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	2,561	$24,310
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	10,118	$88,910
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	10,118	$88,910
	Small Acreage Grazing System (SL-6A)	$3.16	768	$2,430
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	1,281	$7,650
	Stream Protection/Fencing (WP-2T)	$7.38	768	$5,670
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	$700	74	$51,640
	Vegetative Cover on Critical Areas (SL-11)	$2,500	74	$184,420
	Reforestation of Erodible Pasture (FR-1)	$200	75	$14,900
	Pasture Management (EQIP 528, SL-10T)	$75	74	$5,530
	Wet Detention Ponds	$150	0	$0
	Grazing Land Management (SL-9)	$200	10	$2,000
Cropland	Continuous No-Till (SL-15)	$100	7	$650
	Small Grain Cover Crop (SL-8)	$30	18	$550
	Permanent Vegetative Cover on Cropland (SL-1)	$175	28	$4,830
	Sod Waterway (WP-3)	$2,500	2	$5,450
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	2	$2,180
	Vegetative Cover on Critical Areas (SL-11)	$2,500	5	$12,720
	Reforestation of Erodible Pasture (FR-1)	$200	28	$5,520
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	45	$8,930
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	8	$40,360
	Septic System Installation/Replacement (RB-4)	$8,000	5	$43,050
	Alternative Waste Treatment System (RB-5)	$16,000	2	$32,290
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	90	8	$730
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	150	$1,500,000
	Rain Gardens	$5,000	150	$750,000
	Infiltration Trench	$6,000	50	$300,000
	Manufactured BMP	$20,000	150	$3,000,000
	Constructed Wetland	$2,900	150	$435,000
	Detention Pond	$3,800	145	$551,000
	Riparian Buffer: Forest (acre-installed)	$3,500	1	$4,590
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	1	$470
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$7,187,190**

Table 5-17. Miry Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	1,854	$17,600
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	7,325	$64,370
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	7,325	$64,370
	Small Acreage Grazing System (SL-6A)	$3.16	556	$1,760
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	927	$5,540
	Stream Protection/Fencing (WP-2T)	$7.38	556	$4,110
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	$700	70	$49,140
	Vegetative Cover on Critical Areas (SL-11)	$2,500	70	$175,490
	Reforestation of Erodible Pasture (FR-1)	$200	71	$14,180
	Pasture Management (EQIP 528, SL-10T)	$75	702	$52,650
	Wet Detention Ponds	$150	0	$0
	Grazing Land Management (SL-9)	$200	10	$2,000
Cropland	Continuous No-Till (SL-15)	$100	6	$620
	Small Grain Cover Crop (SL-8)	$30	7	$200
	Permanent Vegetative Cover on Cropland (SL-1)	$175	6	$1,000
	Sod Waterway (WP-3)	$2,500	1	$1,910
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$770
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1	$1,910
	Reforestation of Erodible Pasture (FR-1)	$200	6	$1,150
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	49	$9,860
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	9	$45,000
	Septic System Installation/Replacement (RB-4)	$8,000	7	$54,000
	Alternative Waste Treatment System (RB-5)	$16,000	2	$36,000
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	15	$4,500
	Pet Waste Composter	$90	9	$810
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	100	$1,000,000
	Rain Gardens	$5,000	100	$500,000
	Infiltration Trench	$6,000	100	$600,000
	Manufactured BMP	$20,000	80	$1,600,000
	Constructed Wetland	$2,900	100	$290,000
	Detention Pond	$3,800	50	$190,000
	Riparian Buffer: Forest (acre-installed)	$3,500	1	$2,720
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	1	$280
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$4,804,440**

Table 5-18. Pumpkin Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	122	$1,160
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	483	$4,250
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	483	$4,250
	Small Acreage Grazing System (SL-6A)	$3.16	37	$120
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	61	$370
	Stream Protection/Fencing (WP-2T)	$7.38	37	$270
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	1	$58,000
	Woodland buffer filter area (FR-3)	$700	24	$16,990
	Vegetative Cover on Critical Areas (SL-11)	$2,500	316	$788,920
	Reforestation of Erodible Pasture (FR-1)	$200	121	$24,270
	Pasture Management (EQIP 528, SL-10T)	$75	49	$3,640
	Wet Detention Ponds	$150	75	$11,250
	Grazing Land Management (SL-9)	$200	50	$10,000
Cropland	Continuous No-Till (SL-15)	$100	0	$30
	Small Grain Cover Crop (SL-8)	$30	7	$220
	Permanent Vegetative Cover on Cropland (SL-1)	$175	5	$800
	Sod Waterway (WP-3)	$2,500	0	$860
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	0	$340
	Vegetative Cover on Critical Areas (SL-11)	$2,500	0	$860
	Reforestation of Erodible Pasture (FR-1)	$200	5	$1,030
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	106	$21,290
	Sewer Connection (RB-2)	$11,000	119	$1,309,000
	Repaired Septic System (RB-3)	$5,000	44	$217,750
	Septic System Installation/Replacement (RB-4)	$8,000	64	$508,000
	Alternative Waste Treatment System (RB-5)	$16,000	33	$531,200
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	2	$600
	Pet Waste Composter	$90	14	$1,260
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	300	$3,000,000
	Rain Gardens	$5,000	225	$1,125,000
	Infiltration Trench	$6,000	200	$1,200,000
	Manufactured BMP	$20,000	200	$4,000,000
	Constructed Wetland	$2,900	210	$609,000
	Detention Pond	$3,800	150	$570,000
	Riparian Buffer: Forest (acre-installed)	$3,500	19	$64,990
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	19	$6,680
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$14,104,900**

Table 5-19. Sandy Creek (east) Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	303	$2,870
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	1,196	$10,510
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	1,196	$10,510
	Small Acreage Grazing System (SL-6A)	$3.16	91	$290
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	151	$900
	Stream Protection/Fencing (WP-2T)	$7.38	91	$670
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	$700	42	$29,560
	Vegetative Cover on Critical Areas (SL-11)	$2,500	718	$1,794,540
	Reforestation of Erodible Pasture (FR-1)	$200	469	$93,830
	Pasture Management (EQIP 528, SL-10T)	$75	633	$47,500
	Wet Detention Ponds	$150	0	$0
	Grazing Land Management (SL-9)	$200	0	$0
Cropland	Continuous No-Till (SL-15)	$100	1	$130
	Small Grain Cover Crop (SL-8)	$30	2	$60
	Permanent Vegetative Cover on Cropland (SL-1)	$175	4	$630
	Sod Waterway (WP-3)	$2,500	1	$3,610
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$720
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1	$3,610
	Reforestation of Erodible Pasture (FR-1)	$200	4	$790
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	64	$12,810
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	11	$57,000
	Septic System Installation/Replacement (RB-4)	$8,000	7	$54,000
	Alternative Waste Treatment System (RB-5)	$16,000	3	$45,600
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	1	$300
	Pet Waste Composter	$90	12	$1,050
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	100	$1,000,000
	Rain Gardens	$5,000	100	$500,000
	Infiltration Trench	$6,000	50	$300,000
	Manufactured BMP	$20,000	50	$1,000,000
	Constructed Wetland	$2,900	75	$217,500
	Detention Pond	$3,800	50	$190,000
	Riparian Buffer: Forest (acre-installed)	$3,500	0	$1,730
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0	$180
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$5,393,400**

Table 5-20. Stokes Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	343	$3,260
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	1,355	$11,910
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	1,355	$11,910
	Small Acreage Grazing System (SL-6A)	$3.16	103	$330
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	172	$1,030
	Stream Protection/Fencing (WP-2T)	$7.38	103	$760
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	$700	36	$25,020
	Vegetative Cover on Critical Areas (SL-11)	$2,500	36	$89,350
	Reforestation of Erodible Pasture (FR-1)	$200	36	$7,220
	Pasture Management (EQIP 528, SL-10T)	$75	36	$2,680
	Wet Detention Ponds	$150	0	$0
	Grazing Land Management (SL-9)	$200	0	$0
Cropland	Continuous No-Till (SL-15)	$100	22	$2,170
	Small Grain Cover Crop (SL-8)	$30	5	$150
	Permanent Vegetative Cover on Cropland (SL-1)	$175	13	$2,270
	Sod Waterway (WP-3)	$2,500	1	$3,250
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$1,300
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1	$3,250
	Reforestation of Erodible Pasture (FR-1)	$200	13	$2,600
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	22	$4,340
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	4	$19,640
	Septic System Installation/Replacement (RB-4)	$8,000	3	$20,950
	Alternative Waste Treatment System (RB-5)	$16,000	1	$15,710
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	4	$360
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	100	$1,000,000
	Rain Gardens	$5,000	58	$290,000
	Infiltration Trench	$6,000	50	$300,000
	Manufactured BMP	$20,000	50	$1,000,000
	Constructed Wetland	$2,900	55	$159,500
	Detention Pond	$3,800	50	$190,000
	Riparian Buffer: Forest (acre-installed)	$3,500	1	$4,630
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	1	$480
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$3,186,570**

Table 5-21. Powell's Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	771	$7,310
	Livestock Exclusion for TMDL IP (SL-6)	$8.79	3,044	$26,750
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	3,044	$26,750
	Small Acreage Grazing System (SL-6A)	$3.16	231	$730
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	385	$2,300
	Stream Protection/Fencing (WP-2T)	$7.38	231	$1,710
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	2.5	$145,000
	Woodland buffer filter area (FR-3)	$700	63	$44,100
	Vegetative Cover on Critical Areas (SL-11)	$2,500	819	$2,047,670
	Reforestation of Erodible Pasture (FR-1)	$200	315	$63,010
	Pasture Management (EQIP 528, SL-10T)	$75	126	$9,450
	Wet Detention Ponds	$150	300	$45,000
	Grazing Land Management (SL-9)	$200	100	$20,000
Cropland	Continuous No-Till (SL-15)	$100	2	$170
	Small Grain Cover Crop (SL-8)	$30	2	$50
	Permanent Vegetative Cover on Cropland (SL-1)	$175	2	$330
	Sod Waterway (WP-3)	$2,500	0	$720
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	0	$290
	Vegetative Cover on Critical Areas (SL-11)	$2,500	0	$720
	Reforestation of Erodible Pasture (FR-1)	$200	2	$400
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	17	$3,410
	Sewer Connection (RB-2)	$11,000		$0
	Repaired Septic System (RB-3)	$5,000	3	$15,000
	Septic System Installation/Replacement (RB-4)	$8,000	2	$18,000
	Alternative Waste Treatment System (RB-5)	$16,000	1	$12,000
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$500	15	$7,500
	Pet Waste Composter	175	3	$540
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	30	$300,000
	Rain Gardens	$5,000	16	$80,000
	Infiltration Trench	$6,000	19	$114,000
	Manufactured BMP	$20,000	17	$340,000
	Constructed Wetland	$2,900	20	$58,000
	Detention Pond	$3,800	21	$79,800
	Riparian Buffer: Forest (acre-installed)	$3,500	1	$1,920
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	1	$200
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$3,485,330**

Table 5-22. Birch Creek Subwatershed TMDL IP Costs

Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	855	$8,112
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	3,376	$29,670
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	3,376	$29,670
	Small Acreage Grazing System (SL-6AT)	$3.16	256	$811
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	427	$2,554
	Stream Protection/Fencing (WP-2T)	$7.38	256	$1,893
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	$700	223	$156,190
	Vegetative Cover on Critical Areas (SL-11)	$2,500	558	$1,394,540
	Reforestation of Erodible Pasture (FR-1)	$200	228	$45,540
	Pasture Management (EQIP 528, SL-10T)	$75	335	$25,100
	Wet Detention Ponds (acre-treated)	$150	0	$0
	Grazing Land Management (SL-9)	$200	0	$0
Cropland	Continuous No-Till (SL-15)	$100	23	$2,270
	Small Grain Cover Crop (SL-8)	$30	24	$730
	Permanent Vegetative Cover on Cropland (SL-1)	$175	50	$8,740
	Sod Waterway (WP-3)	$2,500	8	$18,910
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	8	$7,560
	Vegetative Cover on Critical Areas (SL-11)	$2,500	8	$18,910
	Reforestation of Erodible Pasture (FR-1)	$200	53	$10,530
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	126	$25,170
	Sewer Connection (Targeted Areas and RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	23	$112,632
	Septic System Installation/Replacement (RB-4)	$8,000	14	$115,135
	Alternative Waste Treatment System (RB-5)	$16,000	6	$90,106
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet waste Composter	$90	23	$2,067.05
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	275	$2,750,000
	Rain Gardens	$5,000	275	$1,375,000
	Infiltration Trench	$6,000	50	$300,000
	Manufactured BMP	$20,000	20	$400,000
	Constructed Wetland	$2,900	120	$348,000
	Detention Pond	$3,800	10	$38,000
	Riparian Buffer: Forest (acre-installed)	$3,500	2	$5,390
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	2	$550
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$7,336,280**

Table 5-23. Birch Creek, UT Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	220	$2,090
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	870	$7,644
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	870	$7,644
	Small Acreage Grazing System (SL-6AT)	$3.16	66	$209
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	110	$658
	Stream Protection/Fencing (WP-2T)	$7.38	66	$488
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	**$700**	16	$11,520
	Vegetative Cover on Critical Areas (SL-11)	$2,500	82	$205,660
	Reforestation of Erodible Pasture (FR-1)	$200	17	$3,320
	Pasture Management (EQIP 528, SL-10T)	$75	16	$1,230
	Wet Detention Ponds (acre-treated)	$150	0	$0
	Grazing Land Management (SL-9)	$200	25	$5,000
Cropland	Continuous No-Till (SL-15)	$100	0	$0
	Small Grain Cover Crop (SL-8)	$30	0	$0
	Permanent Vegetative Cover on Cropland (SL-1)	$175	0	$0
	Sod Waterway (WP-3)	$2,500	0	$0
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	0	$0
	Vegetative Cover on Critical Areas (SL-11)	$2,500	0	$0
	Reforestation of Erodible Pasture (FR-1)	$200	0	$0
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	12	$2,460
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	2	$11,030
	Septic System Installation/Replacement (RB-4)	$8,000	1	$11,270
	Alternative Waste Treatment System (RB-5)	$16,000	1	$8,820
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	2	$200
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	20	$200,000
	Rain Gardens	$5,000	12	$60,000
	Infiltration Trench	$6,000	10	$60,000
	Manufactured BMP	$20,000	11	$220,000
	Constructed Wetland	$2,900	16	$46,400
	Detention Pond	$3,800	6	$22,800
	Riparian Buffer: Forest (acre-installed)	$3,500	0	$0
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0	$0
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$900,940**

Table 5-24. Germy Creek Subwatershed TMDL IP Costs

Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	20	$193
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	80	$706
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	80	$706
	Small Acreage Grazing System (SL-6AT)	$3.16	6	$19
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	10	$61
	Stream Protection/Fencing (WP-2T)	$7.38	6	$45
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	1.63	$94,540
	Woodland buffer filter area (FR-3)	$700	40	$27,730
	Vegetative Cover on Critical Areas (SL-11)	$2,500	515	$1,287,310
	Reforestation of Erodible Pasture (FR-1)	$200	198	$39,610
	Pasture Management (EQIP 528, SL-10T)	$75	79	$5,940
	Wet Detention Ponds	$150	192	$28,800
	Grazing Land Management (SL-9)	$200	100	$20,000
Cropland	Continuous No-Till (SL-15)	$100	8	$810
	Small Grain Cover Crop (SL-8)	$30	8	$240
	Permanent Vegetative Cover on Cropland (SL-1)	$175	10	$1,700
	Sod Waterway (WP-3)	$2,500	1	$1,970
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$790
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1	$1,970
	Reforestation of Erodible Pasture (FR-1)	$200	9	$1,890
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	13	$2,530
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	2	$11,340
	Septic System Installation/Replacement (RB-4)	$8,000	1	$11,590
	Alternative Waste Treatment System	$16,000	1	$9,070
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	2	$210
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	25	$250,000
	Rain Gardens	$5,000	15	$75,000
	Infiltration Trench	$6,000	9	$54,000
	Manufactured BMP	$20,000	10	$200,000
	Constructed Wetland	$2,900	10	$29,000
	Detention Pond	$3,800	11	$41,800
	Riparian Buffer: Forest (acre-installed)	$3,500	0	$0
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0	$0
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$2,212,070**

Table 5-25. Fall Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	683	$6,486
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	2,700	$23,723
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	2,700	$23,723
	Small Acreage Grazing System (SL-6AT)	$3.16	205	$649
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	342	$2,042
	Stream Protection/Fencing (WP-2T)	$7.38	205	$1,513
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	10	$580,000
	Woodland buffer filter area (FR-3)	$700	258	$180,560
	Vegetative Cover on Critical Areas (SL-11)	$2,500	3,431	$8,576,780
	Reforestation of Erodible Pasture (FR-1)	$200	1,290	$257,950
	Pasture Management (EQIP 528, SL-10T)	$75	516	$38,690
	Wet Detention Ponds (acre-treated)	$150	1,500	$225,000
	Grazing Land Management (SL-9)	$200	300	$60,000
Cropland	Continuous No-Till (SL-15)	$100	14	$1,440
	Small Grain Cover Crop (SL-8)	$30	15	$440
	Permanent Vegetative Cover on Cropland (SL-1)	$175	17	$2,980
	Sod Waterway (WP-3)	$2,500	2	$6,090
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	2	$2,430
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2	$6,090
	Reforestation of Erodible Pasture (FR-1)	$200	17	$3,360
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	127	$25,355
	Sewer Connection (Targeted Areas and RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	23	$112,770
	Septic System Installation/Replacement (RB-4)	$8,000	25	$199,868
	Alternative Waste Treatment System (RB-5)	$16,000	6	$90,216
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	1	$300
	Pet waste Composter	$90	23	$2,082.25
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	550	$5,500,000
	Rain Gardens	$5,000	550	$2,750,000
	Infiltration Trench	$6,000	250	$1,500,000
	Manufactured BMP	$20,000	250	$5,000,000
	Constructed Wetland	$2,900	550	$1,595,000
	Detention Pond	$3,800	100	$380,000
	Riparian Buffer: Forest (acre-installed)	$3,500	10	$33,920
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	10	$3,490
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$27,205,450**

Table 5-26. Lawless Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	37	$348
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	145	$1,274
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	145	$1,274
	Small Acreage Grazing System (SL-6AT)	$3.16	11	$35
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	18	$110
	Stream Protection/Fencing (WP-2T)	$7.38	11	$81
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	**2.5**	$145,000
	Woodland buffer filter area (FR-3)	**$700**	120	$84,000
	Vegetative Cover on Critical Areas (SL-11)	$2,500	807	$2,017,330
	Reforestation of Erodible Pasture (FR-1)	$200	310	$62,070
	Pasture Management (EQIP 528, SL-10T)	$75	124	$9,310
	Wet Detention Ponds (acre-treated)	$150	337	$50,550
	Grazing Land Management (SL-9)	$200	50	$10,000
Cropland	Continuous No-Till (SL-15)	$100	1	$70
	Small Grain Cover Crop (SL-8)	$30	0	$10
	Permanent Vegetative Cover on Cropland (SL-1)	$175	25	$4,300
	Sod Waterway (WP-3)	$2,500	1	$1,250
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$500
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2	$5,900
	Reforestation of Erodible Pasture (FR-1)	$200	25	$4,910
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	12	$2,300
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	2	$10,230
	Septic System Installation/Replacement (RB-4)	$8,000	2	$18,130
	Alternative Waste Treatment System (RB-5)	$16,000	1	$8,180
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	2	$190
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	52	$520,000
	Rain Gardens	$5,000	25	$125,000
	Infiltration Trench	$6,000	25	$150,000
	Manufactured BMP	$20,000	25	$500,000
	Constructed Wetland	$2,900	50	$145,000
	Detention Pond	$3,800	50	$190,000
	Riparian Buffer: Forest (acre-installed)	$3,500	0	$1,140
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0	$120
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$4,081,110**

Table 5-27. Double Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	512	$4,862
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	2,024	$17,783
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	2,024	$17,783
	Small Acreage Grazing System (SL-6AT)	$3.16	154	$486
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	256	$1,531
	Stream Protection/Fencing (WP-2T)	$7.38	154	$1,134
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	**1**	$58,000
	Woodland buffer filter area (FR-3)	$700	36	$25,110
	Vegetative Cover on Critical Areas (SL-11)	$2,500	36	$89,670
	Reforestation of Erodible Pasture (FR-1)	$200	36	$7,250
	Pasture Management (EQIP 528, SL-10T)	$75	36	$2,690
	Wet Detention Ponds (acre-treated)	$150	0	$0
	Grazing Land Management (SL-9)	$200	10	$2,000
Cropland	Continuous No-Till (SL-15)	$100	5	$520
	Small Grain Cover Crop (SL-8)	$30	5	$160
	Permanent Vegetative Cover on Cropland (SL-1)	$175	1	$90
	Sod Waterway (WP-3)	$2,500	1	$1,350
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$540
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1	$1,350
	Reforestation of Erodible Pasture (FR-1)	$200	1	$110
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	41	$8,190
	Sewer Connection (RB-2)	$11,000		$0
	Repaired Septic System (RB-3)	$5,000	7	$36,000
	Septic System Installation/Replacement (RB-4)	$8,000	4	$32,000
	Alternative Waste Treatment System (RB-5)	$16,000	2	$28,800
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	7	$670
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	25	$250,000
	Rain Gardens	$5,000	25	$125,000
	Infiltration Trench	$6,000	22	$132,000
	Manufactured BMP	$20,000	22	$440,000
	Constructed Wetland	$2,900	24	$69,600
	Detention Pond	$3,800	0	$0
	Riparian Buffer: Forest (acre-installed)	$3,500	0	$360
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0	$40
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$1,367,580**

Table 5-28. Byrd's Branch Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	69	$655
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	272	$2,394
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	272	$2,394
	Small Acreage Grazing System (SL-6AT)	$3.16	21	$65
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	34	$206
	Stream Protection/Fencing (WP-2T)	$7.38	21	$153
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	$700	6	$4,360
	Vegetative Cover on Critical Areas (SL-11)	$2,500	6	$15,560
	Reforestation of Erodible Pasture (FR-1)	$200	6	$1,260
	Pasture Management (EQIP 528, SL-10T)	$75	31	$2,330
	Wet Detention Ponds (acre-treated)	$150	0	$0
	Grazing Land Management (SL-9)	$200	0	$0
Cropland	Continuous No-Till (SL-15)	$100	9	$860
	Small Grain Cover Crop (SL-8)	$30	6	$180
	Permanent Vegetative Cover on Cropland (SL-1)	$175	1	$90
	Sod Waterway (WP-3)	$2,500	1	$1,270
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$510
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1	$1,270
	Reforestation of Erodible Pasture (FR-1)	$200	1	$100
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	5	$950
	Sewer Connection (RB-2)	$11,000		$0
	Repaired Septic System (RB-3)	$5,000	1	$3,000
	Septic System Installation/Replacement (RB-4)	$8,000	0	$0
	Alternative Waste Treatment System (RB-5)	$16,000	0	$0
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	1	$80
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	10	$100,000
	Rain Gardens	$5,000	10	$50,000
	Infiltration Trench	$6,000	10	$60,000
	Manufactured BMP	$20,000	9	$180,000
	Constructed Wetland	$2,900	6	$17,400
	Detention Pond	$3,800	4	$15,200
	Riparian Buffer: Forest (acre-installed)	$3,500	0	$0
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0	$0
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$472,790**

Table 5-29. Sandy River (north) Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	2,905	$27,574
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	11,477	$100,849
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	11,477	$100,849
	Small Acreage Grazing System (SL-6AT)	$3.16	872	$2,757
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	1,453	$8,681
	Stream Protection/Fencing (WP-2T)	$7.38	872	$6,434
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Manure Storage (WP-4) - Dairy	$58,000	1	$58,000
	Woodland buffer filter area (FR-3)	$700	98	$68,660
	Vegetative Cover on Critical Areas (SL-11)	$2,500	490	$1,225,980
	Reforestation of Erodible Pasture (FR-1)	$200	99	$19,810
	Pasture Management (EQIP 528, SL-10T)	$75	490	$36,780
	Wet Detention Ponds (acre-treated)	$150	10	$1,500
	Grazing Land Management (SL-9)	$200	10	$2,000
Cropland	Continuous No-Till (SL-15)	$100	3	$290
	Small Grain Cover Crop (SL-8)	$30	3	$90
	Permanent Vegetative Cover on Cropland (SL-1)	$175	1	$110
	Sod Waterway (WP-3)	$2,500	1	$1,500
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$600
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1	$1,500
	Reforestation of Erodible Pasture (FR-1)	$200	1	$120
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	136	$27,240
	Sewer Connection (Targeted Areas and RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	25	$123,000
	Septic System Installation/Replacement (RB-4)	$8,000	15	$122,000
	Alternative Waste Treatment System (RB-5)	$16,000	6	$98,400
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet waste Composter	$90	25	$2,237.06
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	110	$1,100,000
	Rain Gardens	$5,000	100	$500,000
	Infiltration Trench	$6,000	100	$600,000
	Manufactured BMP	$20,000	100	$2,000,000
	Constructed Wetland	$2,900	100	$290,000
	Detention Pond	$3,800	100	$380,000
	Riparian Buffer: Forest (acre-installed)	$3,500	0	$1,530
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0	$160
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500.00
			Total Subwatershed IP Cost	**$6,921,150**

Table 5-30. Sandy River (south) Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	3,023	$28,686
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	11,939	$104,915
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	11,939	$104,915
	Small Acreage Grazing System (SL-6AT)	$3.16	907	$2,869
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	1,511	$9,031
	Stream Protection/Fencing (WP-2T)	$7.38	907	$6,693
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	15	$870,000
	Woodland buffer filter area (FR-3)	$700	412	$288,340
	Vegetative Cover on Critical Areas (SL-11)	$2,500	5,355	$13,387,240
	Reforestation of Erodible Pasture (FR-1)	$200	2,392	$478,350
	Pasture Management (EQIP 528, SL-10T)	$75	1,236	$92,680
	Wet Detention Ponds (acre-treated)	$150	1,850	$277,500
	Grazing Land Management (SL-9)	$200	475	$95,000
Cropland	Continuous No-Till (SL-15)	$100	24	$2,360
	Small Grain Cover Crop (SL-8)	$30	24	$710
	Permanent Vegetative Cover on Cropland (SL-1)	$175	24	$4,130
	Sod Waterway (WP-3)	$2,500	2	$5,900
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	2	$1,570
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2	$3,940
	Reforestation of Erodible Pasture (FR-1)	$200	21	$4,250
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	156	$31,270
	Sewer Connection (RB-2)	$11,000	44	$484,000
	Repaired Septic System (RB-3)	$5,000	35	$175,810
	Septic System Installation/Replacement (RB-4)	$8,000	33	$261,020
	Alternative Waste Treatment System (RB-5)	$16,000	15	$241,980
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	3	$900
	Pet Waste Composter	$90	27	$2,430
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	400	$4,000,000
	Rain Gardens	$5,000	400	$2,000,000
	Infiltration Trench	$6,000	250	$1,500,000
	Manufactured BMP	$20,000	250	$5,000,000
	Constructed Wetland	$2,900	225	$652,500
	Detention Pond	$3,800	200	$760,000
	Riparian Buffer: Forest (acre-installed)	$3,500	3	$9,450
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	3	$970
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$30,901,910**

Table 5-31. Sandy Creek (west) Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	2,327	$22,083
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	9,191	$80,766
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	9,191	$80,766
	Small Acreage Grazing System (SL-6AT)	$3.16	698	$2,208
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	1,163	$6,952
	Stream Protection/Fencing (WP-2T)	$7.38	698	$5,153
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	$700	748	$523,690
	Vegetative Cover on Critical Areas (SL-11)	$2,500	4,863	$12,157,050
	Reforestation of Erodible Pasture (FR-1)	$200	831	$166,250
	Pasture Management (EQIP 528, SL-10T)	$75	748	$56,110
	Wet Detention Ponds	$150	50	$7,500
	Grazing Land Management (SL-9)	$200	0	$0
Cropland	Continuous No-Till (SL-15)	$100	17	$1,750
	Small Grain Cover Crop (SL-8)	$30	17	$520
	Permanent Vegetative Cover on Cropland (SL-1)	$175	11	$1,990
	Sod Waterway (WP-3)	$2,500	4	$9,830
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	4	$3,850
	Vegetative Cover on Critical Areas (SL-11)	$2,500	4	$9,830
	Reforestation of Erodible Pasture (FR-1)	$200	12	$2,360
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	142	$28,330
	Sewer Connection (RB-2)	$11,000	115	$1,265,000
	Repaired Septic System (RB-3)	$5,000	49	$245,750
	Septic System Installation/Replacement (RB-4)	$8,000	45	$362,000
	Alternative Waste Treatment System	$16,000	34	$541,600
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	21	$1,850
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	350	$3,500,000
	Rain Gardens	$5,000	350	$1,750,000
	Infiltration Trench	$6,000	250	$1,500,000
	Manufactured BMP	$20,000	250	$5,000,000
	Constructed Wetland	$2,900	258	$748,200
	Detention Pond	$3,800	230	$874,000
	Riparian Buffer: Forest (acre-installed)	$3,500	5	$15,750
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	5	$1,620
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$28,985,260**

Table 5-32. Stewart Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	798	$7,580
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	3,153	$27,710
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	3,153	$27,710
	Small Acreage Grazing System (SL-6A)	$3.16	239	$760
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	399	$2,380
	Stream Protection/Fencing (WP-2T)	$7.38	239	$1,770
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	7.15	$414,700
	Woodland buffer filter area (FR-3)	$700	381	$266,610
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2,476	$6,189,050
	Reforestation of Erodible Pasture (FR-1)	$200	423	$84,640
	Pasture Management (EQIP 528, SL-10T)	$75	381	$28,560
	Wet Detention Ponds	$150	1,025	$153,750
	Grazing Land Management (SL-9)	$200	300	$60,000
Cropland	Continuous No-Till (SL-15)	$100	12	$1,190
	Small Grain Cover Crop (SL-8)	$30	11	$330
	Permanent Vegetative Cover on Cropland (SL-1)	$175	10	$1,710
	Sod Waterway (WP-3)	$2,500	2	$5,940
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	2	$1,980
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2	$4,950
	Reforestation of Erodible Pasture (FR-1)	$200	10	$2,020
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	30	$6,070
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	7	$34,130
	Septic System Installation/Replacement (RB-4)	$8,000	6	$50,670
	Alternative Waste Treatment System (RB-5)	$16,000	3	$46,970
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$500	0	$0
	Pet Waste Composter	$175	5	$920
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	125	$1,250,000
	Rain Gardens	$5,000	125	$625,000
	Infiltration Trench	$6,000	20	$120,000
	Manufactured BMP	$20,000	20	$400,000
	Constructed Wetland	$2,900	25	$72,500
	Detention Pond	$3,800	0	$0
	Riparian Buffer: Forest (acre-installed)	$3,500	0	$1,570
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0	$160
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$9,903,830**

Table 5-33. Sugartree Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Systems**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	674	$6,390
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	2,661	$23,390
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	2,661	$23,390
	Small Acreage Grazing System (SL-6A)	$3.16	202	$640
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	337	$2,010
	Stream Protection/Fencing (WP-2T)	$7.38	202	$1,490
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Manure Storage (WP-4) - Beef	$58,000	3.15	$182,700
	Woodland buffer filter area (FR-3)	$700	82	$57,380
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1,066	$2,664,280
	Reforestation of Erodible Pasture (FR-1)	$200	410	$81,980
	Pasture Management (EQIP 528, SL-10T)	$75	164	$12,300
	Wet Detention Ponds	$150	500	$75,000
	Grazing Land Management (SL-9)	$200	100	$20,000
Cropland	Continuous No-Till (SL-15)	$100	1	$70
	Small Grain Cover Crop (SL-8)	$30	1	$20
	Permanent Vegetative Cover on Cropland (SL-1)	$175	1	$120
	Sod Waterway (WP-3)	$2,500	1	$1,720
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$690
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1	$1,720
	Reforestation of Erodible Pasture (FR-1)	$200	1	$140
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$200	17	$3,390
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	4	$19,070
	Septic System Installation/Replacement (RB-4)	$8,000	4	$28,310
	Alternative Waste Treatment System (RB-5)	$16,000	2	$26,240
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	3	$260
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	35	$350,000
	Rain Gardens	$5,000	35	$175,000
	Infiltration Trench	$6,000	35	$210,000
	Manufactured BMP	$20,000	30	$600,000
	Constructed Wetland	$2,900	30	$87,000
	Detention Pond	$3,800	20	$76,000
	Riparian Buffer: Forest (acre-installed)	$3,500	1	$2,600
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	1	$270
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500

Table 5-34. Tanyard Creek Subwatershed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per foot)**	**Feet Proposed**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$9.49	1,484	$14,080
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$8.79	5,861	$51,500
	Livestock Exclusion for TMDL IP (LE-1T)	$8.79	5,861	$51,500
	Small Acreage Grazing System (SL-6A)	$3.16	445	$1,410
	Livestock Exclusion with Reduced Setback (LE-2T)	$5.98	742	$4,430
	Stream Protection/Fencing (WP-2T)	$7.38	445	$3,290
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	$700	177	$124,190
	Vegetative Cover on Critical Areas (SL-11)	$2,500	2,111	$5,278,250
	Reforestation of Erodible Pasture (FR-1)	$200	187	$37,350
	Pasture Management (EQIP 528, SL-10T)	$75	355	$26,610
	Wet Detention Ponds	$150	0	$0
	Grazing Land Management (SL-9)	$200	0	$0
Cropland	Continuous No-Till (SL-15)	$100	2	$190
	Small Grain Cover Crop (SL-8)	$30	2	$60
	Permanent Vegetative Cover on Cropland (SL-1)	$175	2	$330
	Sod Waterway (WP-3)	$2,500	1	$2,390
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	1	$960
	Vegetative Cover on Critical Areas (SL-11)	$2,500	1	$2,390
	Reforestation of Erodible Pasture (FR-1)	$200	2	$380
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$175	100	$17,540
	Sewer Connection (RB-2)	$11,000	0	$0
	Repaired Septic System (RB-3)	$5,000	18	$90,000
	Septic System Installation/Replacement (RB-4)	$8,000	12	$92,000
	Alternative Waste Treatment System (RB-5)	$16,000	5	$72,000
Pet Waste	Pet Waste Education Campaign	$5,000	1	$5,000
	Pet Waste Station	$300	0	$0
	Pet Waste Composter	$90	18	$1,650
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	30	$300,000
	Rain Gardens	$5,000	30	$150,000
	Infiltration Trench	$6,000	10	$60,000
	Manufactured BMP	$20,000	10	$200,000
	Constructed Wetland	$2,900	30	$87,000
	Detention Pond	$3,800	17	$64,600
	Riparian Buffer: Forest (acre-installed)	$3,500	0	$1,510
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	0	$160
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	20	$6,000
Stream Stabilization		$75	20	$1,500
			Total Subwatershed IP Cost	**$6,748,270**

Table 5-35. Technical Assistance for Birch Creek and Dan River IP				
BMP Category	**Stage 1 (Year 1-6)**	**Stage 2 (Year 7-12)**	**Stage 3 (Year 13-15)**	**Total**
Agricultural	$960,000	$480,000	$120,000	$1,560,000
Residential	$960,000	$480,000	$240,000	$1,680,000
Urban/Stormwater	$300,000	$300,000	$75,000	$675,000
Total Cost	**$2,220,000**	**$1,260,000**	**$435,000**	**$3,915,000**

Table 5-36. Summary of Cost of Birch Creek and Dan River TMDL IP by Subwatershed					
BMP Category	**Agricultural**	**Residential**	**Urban**	**Stream Restoration**	**Total**
Dan River	$107,274,633	$6,673,910	$83,525,430	$37,500	$197,511,473
Big Toby Creek	$368,684	$78,230	$1,306,260	$7,500	$1,760,674
Cane Creek	$7,655,859	$1,455,580	$6,973,330	$7,500	$16,092,269
Cascade Creek	$6,455,770	$402,210	$2,370,610	$7,500	$9,236,090
Lawson's Creek	$508,270	$130,360	$6,541,060	$7,500	$7,187,190
Miry Creek	$458,770	$155,170	$4,183,000	$7,500	$4,804,440
Pumpkin Creek	$927,630	$2,594,100	$10,575,670	$7,500	$14,104,900
Sandy Creek East	$2,000,730	$175,760	$3,209,410	$7,500	$5,393,400
Stokes Creek	$168,460	$66,000	$2,944,610	$7,500	$3,186,570
Powell's Creek	$2,442,460	$61,450	$973,920	$7,500	$3,485,330
Birch Creek	$1,761,731	$346,964	$5,216,940	$7,500	$7,333,135
Birch Creek, UT	$245,463	$38,480	$609,200	$7,500	$900,643
Germy Creek	$1,515,030	$39,430	$649,800	$7,500	$2,211,760
Fall Creek	$9,410,496	$432,421	$16,762,410	$7,500	$26,612,827
Lawless Creek	$2,398,322	$43,740	$1,631,260	$7,500	$4,080,822
Double Creek	$232,418	$109,640	$1,017,000	$7,500	$1,366,558
Byrd's Branch	$33,656	$8,910	$422,600	$7,500	$472,666
Sandy River North	$1,664,085	$374,472	$4,871,690	$7,500	$6,917,747
Sandy River South	$15,769,078	$1,198,510	$13,922,920	$7,500	$30,898,008
Sandy Creek West	$13,138,657	$2,445,990	$13,389,570	$7,500	$28,981,717
Stewart Creek	$7,283,340	$143,000	$2,469,230	$7,500	$9,903,070
Sugartree Creek	$3,155,430	$81,850	$1,500,870	$7,500	$4,745,650
Tanyard Creek	$5,599,310	$278,190	$863,270	$7,500	$6,748,270

5.5 Benefits of Bacteria Control Measures

The ultimate goal of this IP is to meet water quality standards that support human recreational use and aquatic life. Successful bacteria and sediment reductions through BMPs and educational programs would allow the impaired segments to be delisted. The main benefit of implementation of the various control measures is the improvement of the water quality of Birch Creek, Dan River, and their tributaries. Benefits are derived not only from the resulting clean water but also directly from the actual control measures themselves. Enhanced natural resources also provide for enriched recreational opportunities. Reducing bacteria loads in the Birch Creek and Dan River watersheds will protect human health and safety, promote healthy aquatic communities, improve agricultural production, and add to the economic vitality of communities.

5.5.1 Human Health and Safety

Human, livestock, and wildlife waste can carry viruses and bacteria that are harmful to human health. Although the full range of effects from reduced bacteria loadings on public health is uncertain, the improved water quality should, at the very least, reduce the incidence of infection derived from contact with surface waters (VADCR, 2003). Throughout the United States, the Centers for Disease Control (CDC) estimates that at least 73,000 cases of illnesses and 61 deaths per year are caused by *E. coli* 0157:H7 bacteria (CDC, 2001). Other fecal pathogens (e.g., *E. coli* 0111) are responsible for similar illnesses. Reducing the presence of bacteria in the watershed should considerably reduce the potential of infection from *E. coli* through contact with surface waters. In addition to preventing infection and disease, the measures proposed in this plan to address stormwater could help mitigate and prevent future flooding.

5.5.2 Agricultural Production

This plan recognizes that all farmers face their own unique management challenges. Some of the BMPs in this plan may be more suitable and more cost-effective for one landowner than for another in the watershed. Similarly, the benefits of implementing these practices will vary, but can be estimated based on general research.

Restricting cattle access to streams and providing them with a clean water source can improve weight gain (Surber et al., 2005; Landefeld and Bettinger, 2002). Increasing weight associated

with drinking from off-stream waterers can translate into economic gains for producers as shown in Table 5-37 (Zeckoski et al., 2007). Additionally, keeping cattle in clean, dry areas has been shown to reduce the occurrence of *mastitis* and foot rot. The Virginia Cooperative Extension estimates *mastitis* costs producers $150 per cow in reduced milk production quantity and quality (Jones and Balley, 2009).

Table 5-37. Production Gains Associated with Provision of Clean Water for Cattle

Typical calf sale weight	Additional weight gain with access to clean water[1]	Price	Increased revenue
500 lb/calf	5% (25lb)	$0.60/lb	$15/calf

[1]Source: Surber et al., 2005, Zeckoski et al., 2007

Implementation of an improved pasture management system in conjunction with installation of clean water supplies will also provide economic benefits for the producer. Improved pasture management can allow a producer to feed less hay in winter months, increase stocking rates by 30% to 40% and, consequently, improve the profitability of the operation. Feed costs are typically responsible for 70% to 80% of the cost of growing or maintaining an animal. Pastures provide feed at a cost of 0.01 to 0.02 cents/pound of total digestible nutrients (TDN) compared to 0.04 to 0.06 cents/pound TDN for hay. Therefore, increasing the amount of time that cattle are fed on pasture is a financial benefit to producers (VCE, 1996). Standing forage utilized directly by the grazing animal is always less costly and of higher quality than the same forage harvested with equipment and fed to the animal. In addition to reducing costs to producers, intensive pasture management can boost profits by allowing higher stocking rates and increasing the amount of gain per acre. Another benefit of pasture management systems is that cattle are closely confined allowing for quicker examination and handling. In general, many of the agricultural BMPs recommended in this document will provide both environmental and economic benefits to the farmer.

5.5.3 Economic Benefits of Stormwater and Residential BMPs

Stormwater BMPs can be incorporated into a landscape design as an amenity both on private and public properties. Many BMPs such as buffer strips and infiltration trenches are inexpensive and easy to implement despite limited space and other constraints. Installation of stormwater BMPs

provide educational opportunities to increase awareness of water quality strategies (i.e., watershed plans) and green initiatives.

Potential economic benefits of stormwater BMPs (Wise, 2007):

- Incremental implementation and funding can result in less debt service
- Less capital intensive and may have overall lower costs
- Extend the existing capacity of current infrastructure
- Capture the asset values (ecosystem services) of clean water, soil capacity, and open space amenities
- Reduce wastewater and water treatment costs
- Increase property values and benefits the private sector and public revenue collection

Stormwater infrastructure that reduces stormwater runoff on site can reduce losses from flood damage by $6,700-$9,700 per acre (Medina et al., 2011). Urban stormwater BMPs can also help increase stormwater retention and lower peak discharges, thereby reducing the pressure on and the need for stormwater infrastructure. This can result in lower engineering, land acquisition, and material costs for municipalities and private enterprises.

Individual homeowners and residents could also see financial benefits from stormwater and residential waste treatment BMPs. Proposed BMPs including education and outreach will help give homeowners the knowledge and tools needed for properly maintaining and extending the life of their septic systems. The overall cost of home ownership could be reduced by advocating regular septic pumpouts, which cost about $300 compared to the $3,000-$25,000 cost of a repair or replacement system. Localized and widespread flooding can be expensive at the residential level through property damage and taxpayer costs. Property owners can help mitigate flood water damage and associated costs by reducing stormwater volume and flow rates through installation of infiltration type BMPs such as rain gardens and vegetated swales. Johnston et al. (2006) applied two different methods, one cost based and one value based, for estimating economic benefits of employing conservation design practices (e.g., vegetated swales, green roofs, permeable pavement, and native vegetation). The researchers found quantifiable economic benefits to property values downstream of areas where conservation practices were implemented. Flood damage values were reduced by an average of $6,700-$9,700 per acre for a 100-year event.

5.5.4 Community Economic Vitality

Not only will clean water and improved habitats benefit a landowner that earns their livelihood through their land but it will also benefit the overall regional economy by encouraging outdoor pursuits that stimulate the local economy and employment such as fishing, canoeing, kayaking, hiking, and other recreational tourism.

Healthy watersheds provide many ecosystem services necessary for the well-being of a community. These services include, but are not limited to, water filtration and storage, air filtration, carbon storage, energy and nutrient cycling, removal of pollutants, soil formation, recreation opportunities, food production, and timber harvesting. Many of these services are hard to quantify in terms of dollars and are often undervalued (Bockstael et al., 2000). However, it is understood that many of these services are difficult to replace and often expensive to artificially engineer. Efforts to restore the Birch Creek and Dan River watersheds to a healthier state may reduce the financial burden on residents, businesses, and municipalities who currently bear the cost of damages such as flooding caused by a degraded aquatic system. Improvement of water quality provides greater economic opportunities throughout the area. Lastly, the combined economic and natural resource benefits provide for better quality of life for local and regional residents.

After completion of the IP, organizations in the watershed will be eligible to apply for competitive funding to help cover some of the costs associated with installing the BMPs. These potential funds along with matching funds from other sources will benefit many local contractors involved in the repair and installation of septic systems, construction of livestock exclusion systems, and installation and retrofits of stormwater BMPs. In a 2009 study, researchers estimated that every $1 million invested in environmental efforts such as reforestation, land and watershed restoration, and sustainable forest management, would create approximately 39 jobs (Heintz et al., 2009). Economic benefits to the region and individual stakeholders are an indirect result of the IP.

5.5.5 Cost-Effectiveness Analysis

Tables 5-38 presents the cost-effectiveness of each proposed BMP which has quantifiable bacteria reductions in the Birch Creek and Dan River watersheds. The practices are ranked from

the most to least cost-effective practices for each BMP category. The cost-effectiveness is based on the amount of bacteria (in cfu) reduced per $1,000 spent. The effectiveness values are based on the bacteria loading from the Dan River subwatershed. Because the bacteria loading within each subwatershed varies, the bacteria loads reduced per $1,000 spent would be slightly different for the other subwatersheds.

Table 5-38. BMP Cost Efficiency for Bacteria Reduction in the Dan River Watershed*	
BMP	**Bacteria Reduction per $1000 (in cfu/day)**
Stormwater BMPs	
Riparian Buffer (Grass/Shrub)	1.34E+11
Constructed Wetland	2.66E+10
Riparian Buffer (Forested)	1.57E+10
Infiltration Trench	1.45E+10
Raingarden	1.35E+10
Bioretention	8.68E+09
Detention Pond	7.61E+09
Manufactured BMP	3.86E+09
Residential BMPs	
Pet waste Composter	3.18E+11
Septic System Pump-Out (RB-1)	7.55E+10
Repaired Septic System (RB-3)	5.29E+10
Septic System Installation/Replacement (RB-4)	3.30E+10
Sewer Connection (RB-2)	2.40E+10
Alternative Waste Treatment System Installation (RB-5)	1.65E+10
Pet Waste Management and Education Program	9.64E+09
Cropland BMPs	
Continuous No-Till (SL-15)	1.25E+11
Small Grain Cover Crop (SL-8)	1.19E+11
Reforestation of Erodible Pasture (FR-1)	8.91E+10
Permanent vegetative cover on cropland (SL-1)	7.64E+10
Cropland Buffer/Field Borders (CP-33 and WQ-1)	8.91E+09
Vegetative Cover on Critical Areas (SL-11)	5.35E+09
Sod Waterway (WP-3)	3.56E+09
Pasture BMPs	
Pasture Management (EQIP 528, SL-10T)	4.18E+11
Reforestation of Erodible Pasture (FR-1)	3.13E+11
Wet Detention Ponds	2.93E+11
Grazing Land Management (SL-9)	1.57E+11
Woodland buffer filter area (FR-3)	5.11E+10
Vegetative Cover on Critical Areas (SL-11)	1.88E+10
Manure Storage (WP-4) - Beef	8.65E+08
Livestock Exclusion BMPs	
Small Acreage Grazing System (SL-6AT)	6.17E+09
Livestock Exclusion with Reduced Setback (LE-2/LE-2T)	3.27E+09
Stream Protection/Fencing (WP-2/WP-2T)	2.64E+09
Livestock Exclusion with Grazing Land Management for TMDL IP (SL-6/SL-6T)	2.22E+09
Livestock Exclusion with Riparian Buffers (LE-1T)	2.22E+09
CREP Livestock Exclusion (CRSL-6)	2.06E+09

*The Dan River subwatershed's bacteria loads were used as the basis for this table. Each subwatershed has slightly different bacteria loading due to local conditions.

6.0 Measurable Goals and Milestones for Attaining Water Quality Standards

The primary goals of the Birch Creek and Dan River TMDL IP are to restore water quality in the impaired waterbodies and subsequently de-list the impaired segments from the Virginia 303(d) List of Impaired Waters for bacteria impairments. This chapter outlines specific implementation milestones, water quality milestones, and the link between implementation and water quality improvements; provides a timeline for implementation; and describes additional tracking and monitoring for achieving implementation milestones.

6.1 Milestone Identification

Progress in implementation is established with two types of milestones:

- **Implementation Milestones:** Establish the number of control measures installed within prescribed timeframes.
- **Water Quality Milestones:** Establish the corresponding improvements in water quality that can be expected as the implementation milestones are met.

The implementation of control measures proposed in this IP are projected to take place over three stages over 15 years:

- **Stage 1:** Implementation of the more cost-effective and commonly implemented actions such as livestock exclusion practices, crop and pasture BMPs, septic system repairs/replacements and removal of straight pipes, and pet waste source removal and treatment BMPs.
- **Stage 2:** Implementation of the majority of remaining BMPs to reach the goal of improved water quality.
- **Stage 3:** Implementation of the remainder of the more expensive BMPs necessary to meet the allocated load requirements in the TMDLs.

The IP addresses implementation actions to reduce the anthropogenic sources of bacteria and does not address wildlife reductions for both direct and indirect sources to surface water in the TMDLs.

Tables 6-1 to 6-23 present the three stages for each subwatershed with specific control measures distributed in each stage. Actions listed in each stage are cumulative in nature, and there are place-markers for the later stages to mark when the extent of proposed BMP implementation has been accomplished in a p stage. Also listed is the expected reduction in overall bacteria load at the end of each stage for each watershed.

Table 6-1. Dan River Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	1014		
Sewer Connection (Targeted Areas and RB-2)	System	208		
Repaired Septic System (RB-3)	System	225		
Septic System Installation/Replacement (RB-4)	System	187		
Alternative Waste Treatment System (RB-5)	System	95		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	39		
Pet waste Composter	Unit	176		
	Total Cost	$6,673,910		
Stormwater BMPs				
Bioretention	Acre-Treated	500	1,800	2,000
Rain Gardens	Acre-Treated	1,000	1,800	2,000
Infiltration Trench	Acre-Treated	500	1,800	2,000
Manufactured BMP	Acre-Treated	750	1,350	1,500
Constructed Wetland	Acre-Treated	475	1,710	1,900
Detention Pond	Acre-Treated	375	1,350	1,500
Riparian Buffer: Forest	Acre-Installed	20	61	82
Riparian Buffer: Grass/Shrub	Acre-Installed	41	74	82
	Total Cost	$30,888,713	$44,241,273	$8,395,445
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	19	56	75
Woodland buffer filter area (FR-3)	Acre-Installed	725	2,175	2,900
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	9,425	28,276	37,701
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	5,800	11,600	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	4,640
Wet Detention Ponds	Acre-Treated	1,250	3,750	5,000
Grazing Land Management (SL-9)	Acre-Installed	125	375	500
	Total Cost	$26,530,830	$51,901,620	$25,718,800
Stream Restoration				
Stream Restoration	Feet	50	100	
Stream Stabilization	Feet	50	100	
	Total Cost	$18,750	$18,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	6		
Small Grain Cover Crop (SL-8)	Acre-Treated	13		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	114		
Sod Waterway (WP-3)	Acre-Treated	8		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	8		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	8		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	114		
	Total Cost	$89,560		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	17,833	26,750	35,666
Livestock Exclusion for TMDL IP (SL-6)	Feet	70,441	105,661	140,882
Livestock Exclusion for TMDL IP (LE-1T)	Feet	70,441	105,661	140,882
Small Acreage Grazing System (SL-6AT)	Feet	5,350	8,025	10,700
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	8,917	13,375	17,833
Stream Protection/Fencing (WP-2T)	Feet	5,350	8,025	10,700
	Total Cost	$1,516,912	$758,456	$758,456
Total Cost Per Stage		**$65,718,674**	**$96,920,099**	**$34,872,700**
Bacteria Load Reduction Per Stage (cfu/year)		**2.50E+15**	**3.31E+15**	**3.43E+15**

Table 6-2. Big Toby Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	28		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	5		
Septic System Installation/Replacement (RB-4)	System	3		
Alternative Waste Treatment System (RB-5)	System	1		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	5		
	Total Cost	$78,230		
Stormwater BMPs				
Bioretention	Acre-Treated	13	45	50
Rain Gardens	Acre-Treated	14	25	28
Infiltration Trench	Acre-Treated	6	23	25
Manufactured BMP	Acre-Treated	13	23	26
Constructed Wetland	Acre-Treated	1	2	2
Detention Pond	Acre-Treated	0	0	0
Riparian Buffer: Forest	Acre-Installed	0	0	0
Riparian Buffer: Grass/Shrub	Acre-Installed	0	0	0
	Total Cost	$489,075	$686,496	$130,689
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	0	1	1
Woodland buffer filter area (FR-3)	Acre-Installed	10	31	41
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	10	31	41
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	21	41	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	41
Wet Detention Ponds	Acre-Treated	3	8	10
Grazing Land Management (SL-9)	Acre-Installed	3	8	10
	Total cost	$52,085	$100,055	$51,030
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	8		
Small Grain Cover Crop (SL-8)	Acre-Treated	9		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	36		
Sod Waterway (WP-3)	Acre-Treated	2		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	2		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	2		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	40		
	Total Cost	$25,140		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	825	1,238	1,650
Livestock Exclusion for TMDL IP (SL-6)	Feet	3,259	4,889	6,519
Livestock Exclusion for TMDL IP (LE-1T)	Feet	3,259	4,889	6,519
Small Acreage Grazing System (SL-6AT)	Feet	248	371	495
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	413	619	825
Stream Protection/Fencing (WP-2T)	Feet	248	371	495
	Total Cost	$70,187	$35,094	$35,094
Total Cost Per Stage		**$718,467**	**$825,395**	**$216,813**
Bacteria Load Reduction Per Stage (cfu/year)		**7.21E+12**	**3.91E+12**	**4.35E+12**

Table 6-3. Cane Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	92		
Sewer Connection (Targeted Areas and RB-2)	System	66		
Repaired Septic System (RB-3)	System	30		
Septic System Installation/Replacement (RB-4)	System	29		
Alternative Waste Treatment System (RB-5)	System	20		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	1		
Pet waste Composter	Unit	14		
	Total Cost	$1,455,580		
Stormwater BMPs				
Bioretention	Acre-Treated	50	180	200
Rain Gardens	Acre-Treated	100	180	200
Infiltration Trench	Acre-Treated	50	180	200
Manufactured BMP	Acre-Treated	50	90	100
Constructed Wetland	Acre-Treated	25	90	100
Detention Pond	Acre-Treated	31	113	125
Riparian Buffer: Forest	Acre-Installed	1	2	2
Riparian Buffer: Grass/Shrub	Acre-Installed	1	2	2
	Total Cost	$2,493,528	$3,781,337	$698,466
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	2	6	8
Woodland buffer filter area (FR-3)	Acre-Installed	97	290	387
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	629	1,887	2,516
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	829	1,659	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	503
Wet Detention Ponds	Acre-Treated	125	375	500
Grazing Land Management (SL-9)	Acre-Installed	100	300	400
	Total Cost	$1,953,573	$3,741,260	$1,825,428
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	39		
Small Grain Cover Crop (SL-8)	Acre-Treated	6		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	28		
Sod Waterway (WP-3)	Acre-Treated	2		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	2		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	2		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	28		
	Total Cost	$27,900		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	633	950	1,266
Livestock Exclusion for TMDL IP (SL-6)	Feet	2,501	3,751	5,001
Livestock Exclusion for TMDL IP (LE-1T)	Feet	2,501	3,751	5,001
Small Acreage Grazing System (SL-6AT)	Feet	190	285	380
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	317	475	633
Stream Protection/Fencing (WP-2T)	Feet	190	285	380
	Total Cost	$53,850	$26,925	$26,925
Total Cost Per Stage		**$5,988,180**	**$7,553,272**	**$2,550,818**
Bacteria Load Reduction Per Stage (cfu/year)		**2.02E+13**	**2.64E+13**	**2.38E+13**

Table 6-4. Cascade Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	146		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	26		
Septic System Installation/Replacement (RB-4)	System	16		
Alternative Waste Treatment System (RB-5)	System	7		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	27		
	Total Cost	$402,210		
Stormwater BMPs				
Bioretention	Acre-Treated	19	68	75
Rain Gardens	Acre-Treated	38	68	75
Infiltration Trench	Acre-Treated	15	54	60
Manufactured BMP	Acre-Treated	15	27	30
Constructed Wetland	Acre-Treated	18	63	70
Detention Pond	Acre-Treated	5	18	20
Riparian Buffer: Forest	Acre-Installed	0	1	2
Riparian Buffer: Grass/Shrub	Acre-Installed	1	2	2
	Total Cost	$836,558	$1,296,093	$237,960
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	1	2	2
Woodland buffer filter area (FR-3)	Acre-Installed	14	42	55
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	553	1,660	2,214
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	1,186	2,372	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	553
Wet Detention Ponds	Acre-Treated	38	113	150
Grazing Land Management (SL-9)	Acre-Installed	25	75	100
	Total Cost	$1,672,228	$3,107,275	$1,476,558
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	1		
Small Grain Cover Crop (SL-8)	Acre-Treated	6		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	3		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	3		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	1		
	Total Cost	$ 11,730		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	1,105	1,658	2,210
Livestock Exclusion for TMDL IP (SL-6)	Feet	4,365	6,547	8,730
Livestock Exclusion for TMDL IP (LE-1T)	Feet	4,365	6,547	8,730
Small Acreage Grazing System (SL-6AT)	Feet	332	497	663
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	553	829	1,105
Stream Protection/Fencing (WP-2T)	Feet	332	497	663
	Total Cost	$93,990	$46,995	$46,995
Total Cost Per Stage		**$3,020,465**	**$4,454,113**	**$1,761,512**
Bacteria Load Per Stage (cfu/year)		**2.83E+13**	**3.09E+13**	**2.28E+13**

Table 6-5. Lawson's Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	45		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	8		
Septic System Installation/Replacement (RB-4)	System	5		
Alternative Waste Treatment System (RB-5)	System	2		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	8		
	Total Cost	$130,360		
Stormwater BMPs				
Bioretention	Acre-Treated	38	135	150
Rain Gardens	Acre-Treated	75	135	150
Infiltration Trench	Acre-Treated	13	45	50
Manufactured BMP	Acre-Treated	75	135	150
Constructed Wetland	Acre-Treated	38	135	150
Detention Pond	Acre-Treated	36	131	145
Riparian Buffer: Forest	Acre-Installed	0	1	1
Riparian Buffer: Grass/Shrub	Acre-Installed	1	1	1
	Total Cost	$2,572,883	$3,313,383	$654,795
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed			
Woodland buffer filter area (FR-3)	Acre-Installed	18	55	74
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	18	55	74
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	37	75	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	74
Wet Detention Ponds	Acre-Treated	0	0	0
Grazing Land Management (SL-9)	Acre-Installed	3	8	10
	Total Cost	$66,965	$126,480	$65,045
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	total cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	7		
Small Grain Cover Crop (SL-8)	Acre-Treated	18		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	28		
Sod Waterway (WP-3)	Acre-Treated	2		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	2		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	5		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	28		
	Total Cost	$31,900		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	1,281	1,921	2,561
Livestock Exclusion for TMDL IP (SL-6)	Feet	5,059	7,588	10,118
Livestock Exclusion for TMDL IP (LE-1T)	Feet	5,059	7,588	10,118
Small Acreage Grazing System (SL-6AT)	Feet	384	576	768
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	640	961	1,281
Stream Protection/Fencing (WP-2T)	Feet	384	576	768
	Total Cost	$108,940	$54,470	$54,470
Total Cost Per Stage		**$2,914,798**	**$3,498,083**	**$774,310**
Bacteria Load Per Stage (cfu/year)		**1.58E+13**	**8.29E+12**	**9.14E+12**

Table 6-6. Miry's Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	49		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	9		
Septic System Installation/Replacement (RB-4)	System	7		
Alternative Waste Treatment System (RB-5)	System	2		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	15		
Pet waste Composter	Unit	9		
	Total Cost	$155,170		
Stormwater BMPs				
Bioretention	Acre-Treated	25	90	100
Rain Gardens	Acre-Treated	50	90	100
Infiltration Trench	Acre-Treated	25	90	100
Manufactured BMP	Acre-Treated	40	72	80
Constructed Wetland	Acre-Treated	25	90	100
Detention Pond	Acre-Treated	13	45	50
Riparian Buffer: Forest	Acre-Installed	0	1	1
Riparian Buffer: Grass/Shrub	Acre-Installed	0	1	1
	Total Cost	$1,570,820	$2,193,472	$418,708
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed			
Woodland buffer filter area (FR-3)	Acre-Installed	18	53	70
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	18	53	70
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	35	71	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	702
Wet Detention Ponds	Acre-Treated	0	0	0
Grazing Land Management (SL-9)	Acre-Installed	3	8	10
	Total Cost	$63,748	$120,405	$109,308
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	6		
Small Grain Cover Crop (SL-8)	Acre-Treated	7		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	6		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	1		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	6		
	Total Cost	$7,560		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	927	1,391	1,854
Livestock Exclusion for TMDL IP (SL-6)	Feet	3,663	5,494	7,325
Livestock Exclusion for TMDL IP (LE-1T)	Feet	3,663	5,494	7,325
Small Acreage Grazing System (SL-6AT)	Feet	278	417	556
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	464	695	927
Stream Protection/Fencing (WP-2T)	Feet	278	417	556
	Total Cost	$78,875	$39,438	$39,438
Total Cost Per Stage		**$1,879,923**	**$2,357,065**	**$567,453**
Bacteria Load Per Stage (cfu/year)		**1.73E+13**	**9.17E+12**	**1.19E+13**

Table 6-7. Pumpkin Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	106		
Sewer Connection (Targeted Areas and RB-2)	System	119		
Repaired Septic System (RB-3)	System	44		
Septic System Installation/Replacement (RB-4)	System	64		
Alternative Waste Treatment System (RB-5)	System	33		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	2		
Pet waste Composter	Unit	14		
	Total Cost	$2,594,100		
Stormwater BMPs				
Bioretention	Acre-Treated	75	270	300
Rain Gardens	Acre-Treated	113	203	225
Infiltration Trench	Acre-Treated	50	180	200
Manufactured BMP	Acre-Treated	100	180	200
Constructed Wetland	Acre-Treated	53	189	210
Detention Pond	Acre-Treated	38	135	150
Riparian Buffer: Forest	Acre-Installed	5	14	19
Riparian Buffer: Grass/Shrub	Acre-Installed	9	17	19
	Total Cost	$3,926,838	$5,581,517	$1,067,316
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	0	1	1
Woodland buffer filter area (FR-3)	Acre-Installed	6	18	24
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	79	237	316
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	61	121	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	49
Wet Detention Ponds	Acre-Treated	19	56	75
Grazing Land Management (SL-9)	Acre-Installed	13	38	50
	Total Cost	$233,425	$454,715	$224,930
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	0		
Small Grain Cover Crop (SL-8)	Acre-Treated	7		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	5		
Sod Waterway (WP-3)	Acre-Treated	0		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	0		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	0		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	5		
	Total Cost	$4,140		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	61	92	122
Livestock Exclusion for TMDL IP (SL-6)	Feet	242	363	483
Livestock Exclusion for TMDL IP (LE-1T)	Feet	242	363	483
Small Acreage Grazing System (SL-6AT)	Feet	18	28	37
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	31	46	61
Stream Protection/Fencing (WP-2T)	Feet	18	28	37
	Total Cost	$5,210	$2,605	$2,605
Total Cost Per Stage		**$6,767,463**	**$6,042,587**	**$1,294,851**
Bacteria Load Per Stage (cfu/year)		**8.24E+12**	**1.18E+13**	**1.27E+13**

Table 6-8. Sandy Creek (east) Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	64		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	11		
Septic System Installation/Replacement (RB-4)	System	7		
Alternative Waste Treatment System (RB-5)	System	3		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	1		
Pet waste Composter	Unit	12		
	Total Cost	$175,760		
Stormwater BMPs				
Bioretention	Acre-Treated	25	90	100
Rain Gardens	Acre-Treated	50	90	100
Infiltration Trench	Acre-Treated	13	45	50
Manufactured BMP	Acre-Treated	25	45	50
Constructed Wetland	Acre-Treated	19	68	75
Detention Pond	Acre-Treated	13	45	50
Riparian Buffer: Forest	Acre-Installed	0	0	0
Riparian Buffer: Grass/Shrub	Acre-Installed	0	0	0
	Total Cost	$1,177,398	$1,710,812	$321,201
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed			
Woodland buffer filter area (FR-3)	Acre-Installed	11	32	42
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	179	538	718
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	235	469	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	633
Wet Detention Ponds	Acre-Treated	0	0	0
Grazing Land Management (SL-9)	Acre-Installed	0	0	0
	Total Cost	$502,940	$958,965	$503,525
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	1		
Small Grain Cover Crop (SL-8)	Acre-Treated	2		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	4		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	1		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	4		
	Total Cost	$9,550		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	151	227	303
Livestock Exclusion for TMDL IP (SL-6)	Feet	598	897	1,196
Livestock Exclusion for TMDL IP (LE-1T)	Feet	598	897	1,196
Small Acreage Grazing System (SL-6AT)	Feet	45	68	91
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	76	114	151
Stream Protection/Fencing (WP-2T)	Feet	45	68	91
	Total Cost	$12,875	$6,438	$6,438
Total Cost Per Stage		**$1,882,273**	**$2,679,965**	**$831,163**
Bacteria Load Per Stage (cfu/year)		**7.22E+12**	**7.22E+12**	**7.22E+12**

Table 6-9. Stokes Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	22		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	4		
Septic System Installation/Replacement (RB-4)	System	3		
Alternative Waste Treatment System (RB-5)	System	1		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	4		
	Total Cost	$66,000		
Stormwater BMPs				
Bioretention	Acre-Treated	25	90	100
Rain Gardens	Acre-Treated	29	52	58
Infiltration Trench	Acre-Treated	13	45	50
Manufactured BMP	Acre-Treated	25	45	50
Constructed Wetland	Acre-Treated	14	50	55
Detention Pond	Acre-Treated	13	45	50
Riparian Buffer: Forest	Acre-Installed	0	1	1
Riparian Buffer: Grass/Shrub	Acre-Installed	1	1	1
	Total Cost	$1,058,773	$1,590,682	$295,156
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed			
Woodland buffer filter area (FR-3)	Acre-Installed	9	27	36
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	9	27	36
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	18	36	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	36
Wet Detention Ponds	Acre-Treated	0	0	0
Grazing Land Management (SL-9)	Acre-Installed	0	0	0
	Total Cost	$32,203	$60,795	$31,273
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	22		
Small Grain Cover Crop (SL-8)	Acre-Treated	5		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	13		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	1		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	13		
	Total Cost	$14,990		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	172	257	343
Livestock Exclusion for TMDL IP (SL-6)	Feet	678	1,017	1,355
Livestock Exclusion for TMDL IP (LE-1T)	Feet	678	1,017	1,355
Small Acreage Grazing System (SL-6AT)	Feet	51	77	103
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	86	129	172
Stream Protection/Fencing (WP-2T)	Feet	51	77	103
	Total Cost	$14,600	$7,300	$7,300
Total Cost Per Stage		**$1,190,315**	**$1,662,527**	**$333,728**
Bacteria Load Per Stage (cfu/year)		**7.67E+12**	**3.99E+12**	**4.38E+12**

Table 6-10. Powell's Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	17		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	3		
Septic System Installation/Replacement (RB-4)	System	2		
Alternative Waste Treatment System (RB-5)	System	1		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	15		
Pet waste Composter	Unit	3		
	Total Cost	$61,450		
Stormwater BMPs				
Bioretention	Acre-Treated	8	27	30
Rain Gardens	Acre-Treated	8	14	16
Infiltration Trench	Acre-Treated	5	17	19
Manufactured BMP	Acre-Treated	9	15	17
Constructed Wetland	Acre-Treated	5	18	20
Detention Pond	Acre-Treated	5	19	21
Riparian Buffer: Forest	Acre-Installed	0	0	1
Riparian Buffer: Grass/Shrub	Acre-Installed	0	0	1
	Total Cost	$348,530	$527,710	$97,680
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	1	2	3
Woodland buffer filter area (FR-3)	Acre-Installed	16	47	63
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	205	614	819
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	158	315	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	126
Wet Detention Ponds	Acre-Treated	75	225	300
Grazing Land Management (SL-9)	Acre-Installed	25	75	100
	Total Cost	$606,948	$1,182,390	$584,893
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	2		
Small Grain Cover Crop (SL-8)	Acre-Treated	2		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	2		
Sod Waterway (WP-3)	Acre-Treated	0		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	0		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	0		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	2		
	Total Cost	$2,680		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	385	578	771
Livestock Exclusion for TMDL IP (SL-6)	Feet	1,522	2,283	3,044
Livestock Exclusion for TMDL IP (LE-1T)	Feet	1,522	2,283	3,044
Small Acreage Grazing System (SL-6AT)	Feet	116	173	231
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	193	289	385
Stream Protection/Fencing (WP-2T)	Feet	116	173	231
	Total Cost	$32,775	$16,388	$16,388
Total Cost Per Stage		**$1,056,133**	**$1,730,238**	**$698,960**
Bacteria Load Per Stage (cfu/year)		**1.03E+13**	**1.48E+13**	**1.59E+13**

Table 6-11. Birch Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	126		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	23		
Septic System Installation/Replacement (RB-4)	System	14		
Alternative Waste Treatment System (RB-5)	System	6		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	23		
	Total Cost	$350,110		
Stormwater BMPs				
Bioretention	Acre-Treated	69	248	275
Rain Gardens	Acre-Treated	138	248	275
Infiltration Trench	Acre-Treated	13	45	50
Manufactured BMP	Acre-Treated	10	18	20
Constructed Wetland	Acre-Treated	30	108	120
Detention Pond	Acre-Treated	3	9	10
Riparian Buffer: Forest	Acre-Installed	0	1	2
Riparian Buffer: Grass/Shrub	Acre-Installed	1	1	2
	Total Cost	$1,748,123	$2,946,315	$522,503
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed			
Woodland buffer filter area (FR-3)	Acre-Installed	56	167	223
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	139	418	558
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	114	228	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	335
Wet Detention Ponds	Acre-Treated	0	0	0
Grazing Land Management (SL-9)	Acre-Installed	0	0	0
	Total Cost	$410,453	$798,135	$412,783
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	23		
Small Grain Cover Crop (SL-8)	Acre-Treated	24		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	50		
Sod Waterway (WP-3)	Acre-Treated	8		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	8		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	8		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	53		
	Total Cost	$67,650		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	427	641	855
Livestock Exclusion for TMDL IP (SL-6)	Feet	1,688	2,532	3,376
Livestock Exclusion for TMDL IP (LE-1T)	Feet	1,688	2,532	3,376
Small Acreage Grazing System (SL-6AT)	Feet	128	192	256
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	214	321	427
Stream Protection/Fencing (WP-2T)	Feet	128	192	256
	Total Cost	$36,356	$18,178	$18,178
Total Cost Per Stage		**$2,616,441**	**$3,766,378**	**$953,463**
Bacteria Load Per Stage (cfu/year)		**2.18E+15**	**1.20E+15**	**1.34E+15**

Table 6-12. Birch Creek, UT Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	12		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	2		
Septic System Installation/Replacement (RB-4)	System	1		
Alternative Waste Treatment System (RB-5)	System	1		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	2		
	Total Cost	$38,780		
Stormwater BMPs				
Bioretention	Acre-Treated	5	18	20
Rain Gardens	Acre-Treated	6	11	12
Infiltration Trench	Acre-Treated	3	9	10
Manufactured BMP	Acre-Treated	6	10	11
Constructed Wetland	Acre-Treated	4	14	16
Detention Pond	Acre-Treated	2	5	6
Riparian Buffer: Forest	Acre-Installed	0	0	0
Riparian Buffer: Grass/Shrub	Acre-Installed	0	0	0
	Total Cost	$222,300	$325,980	$60,920
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed			
Woodland buffer filter area (FR-3)	Acre-Installed	4	12	16
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	21	62	82
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	8	17	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	16
Wet Detention Ponds	Acre-Treated	0	0	0
Grazing Land Management (SL-9)	Acre-Installed	6	19	25
	Total Cost	$57,205	$112,750	$56,775
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	0		
Small Grain Cover Crop (SL-8)	Acre-Treated	0		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	0		
Sod Waterway (WP-3)	Acre-Treated	0		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	0		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	0		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	0		
	Total Cost	$0		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	110	165	16
Livestock Exclusion for TMDL IP (SL-6)	Feet	435	652	82
Livestock Exclusion for TMDL IP (LE-1T)	Feet	435	652	17
Small Acreage Grazing System (SL-6AT)	Feet	33	50	16
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	55	83	0
Stream Protection/Fencing (WP-2T)	Feet	33	50	25
	Total Cost	$9,367	$4,683	$4,683
Total Cost Per Stage		**$331,402**	**$447,163**	**$122,378**
Bacteria Load Per Stage (cfu/year)		**3.13E+14**	**1.74E+14**	**1.93E+14**

Table 6-13. Germy Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	13		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	2		
Septic System Installation/Replacement (RB-4)	System	1		
Alternative Waste Treatment System (RB-5)	System	1		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	2		
	Total Cost	$39,740		
Stormwater BMPs				
Bioretention	Acre-Treated	6	23	25
Rain Gardens	Acre-Treated	8	14	15
Infiltration Trench	Acre-Treated	2	8	9
Manufactured BMP	Acre-Treated	5	9	10
Constructed Wetland	Acre-Treated	3	9	10
Detention Pond	Acre-Treated	3	10	11
Riparian Buffer: Forest	Acre-Installed	0	0	0
Riparian Buffer: Grass/Shrub	Acre-Installed	0	0	0
	Total Cost	$231,200	$353,620	$64,980
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	0	1	2
Woodland buffer filter area (FR-3)	Acre-Installed	10	30	40
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	129	386	515
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	99	198	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	79
Wet Detention Ponds	Acre-Treated	48	144	192
Grazing Land Management (SL-9)	Acre-Installed	25	75	100
	Total Cost	$384,400	$748,995	$370,535
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	8		
Small Grain Cover Crop (SL-8)	Acre-Treated	8		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	10		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	1		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	9		
	Total Cost	$9,370		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	10	15	20
Livestock Exclusion for TMDL IP (SL-6)	Feet	40	60	80
Livestock Exclusion for TMDL IP (LE-1T)	Feet	40	60	80
Small Acreage Grazing System (SL-6AT)	Feet	3	5	6
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	5	8	10
Stream Protection/Fencing (WP-2T)	Feet	3	5	6
	Total Cost	$865	$433	$433
Total Cost Per Stage		**$669,325**	**$1,106,798**	**$435,948**
Bacteria Load Per Stage (cfu/year)		**1.93E+14**	**1.12E+14**	**1.24E+14**

Table 6-14. Sandy River (north) Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	136		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	25		
Septic System Installation/Replacement (RB-4)	System	15		
Alternative Waste Treatment System (RB-5)	System	6		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	25		
	Total Cost	$377,877		
Stormwater BMPs				
Bioretention	Acre-Treated	28	99	110
Rain Gardens	Acre-Treated	50	90	100
Infiltration Trench	Acre-Treated	25	90	100
Manufactured BMP	Acre-Treated	50	90	100
Constructed Wetland	Acre-Treated	25	90	100
Detention Pond	Acre-Treated	25	90	100
Riparian Buffer: Forest	Acre-Installed	0	0	0
Riparian Buffer: Grass/Shrub	Acre-Installed	0	0	0
	Total Cost	$1,842,963	$2,541,329	$487,399
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	0	1	1
Woodland buffer filter area (FR-3)	Acre-Installed	25	74	98
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	123	368	490
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	50	99	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	490
Wet Detention Ponds	Acre-Treated	3	8	10
Grazing Land Management (SL-9)	Acre-Installed	3	8	10
	Total Cost	$348,940	$687,975	$375,815
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	3		
Small Grain Cover Crop (SL-8)	Acre-Treated	3		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	1		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	1		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	1		
	Total Cost	$4,210		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	1,453	2,179	2,905
Livestock Exclusion for TMDL IP (SL-6)	Feet	5,738	8,607	11,477
Livestock Exclusion for TMDL IP (LE-1T)	Feet	5,738	8,607	11,477
Small Acreage Grazing System (SL-6AT)	Feet	436	654	872
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	726	1,090	1,453
Stream Protection/Fencing (WP-2T)	Feet	436	654	872
	Total Cost	$123,572	$61,786	$61,786
Total Cost Per Stage		**$2,701,312**	**$3,294,840**	**$925,000**
Bacteria Load Per Stage (cfu/year)		**1.26E+14**	**6.76E+13**	**7.69E+13**

Table 6-15. Sandy River (south) Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	156		
Sewer Connection (Targeted Areas and RB-2)	System	44		
Repaired Septic System (RB-3)	System	35		
Septic System Installation/Replacement (RB-4)	System	33		
Alternative Waste Treatment System (RB-5)	System	15		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	3		
Pet waste Composter	Unit	27		
	Total Cost	$1,202,410		
Stormwater BMPs				
Bioretention	Acre-Treated	100	360	400
Rain Gardens	Acre-Treated	200	360	400
Infiltration Trench	Acre-Treated	63	225	250
Manufactured BMP	Acre-Treated	125	225	250
Constructed Wetland	Acre-Treated	56	203	225
Detention Pond	Acre-Treated	50	180	200
Riparian Buffer: Forest	Acre-Installed	1	2	3
Riparian Buffer: Grass/Shrub	Acre-Installed	1	2	3
	Total Cost	$5,230,973	$7,298,238	$1,393,710
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	4	11	15
Woodland buffer filter area (FR-3)	Acre-Installed	103	309	412
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	1,339	4,016	5,355
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	1,196	2,392	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	1,236
Wet Detention Ponds	Acre-Treated	463	1,388	1,850
Grazing Land Management (SL-9)	Acre-Installed	119	356	475
	Total Cost	$3,968,695	$7,698,215	$3,822,200
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	24		
Small Grain Cover Crop (SL-8)	Acre-Treated	24		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	24		
Sod Waterway (WP-3)	Acre-Treated	2		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	2		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	2		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	21		
	Total Cost	$22,860		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	1,511	2,267	3,023
Livestock Exclusion for TMDL IP (SL-6)	Feet	5,970	8,954	11,939
Livestock Exclusion for TMDL IP (LE-1T)	Feet	5,970	8,954	11,939
Small Acreage Grazing System (SL-6AT)	Feet	453	680	907
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	756	1,133	1,511
Stream Protection/Fencing (WP-2T)	Feet	453	680	907
	Total Cost	$128,554	$64,277	$64,277
Total Cost Per Stage		**$10,557,242**	**$15,064,480**	**$5,280,187**
Bacteria Load Per Stage (cfu/year)		**1.70E+14**	**1.39E+14**	**1.47E+14**

Table 6-16. Sandy Creek (west) Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	142		
Sewer Connection (Targeted Areas and RB-2)	System	115		
Repaired Septic System (RB-3)	System	49		
Septic System Installation/Replacement (RB-4)	System	45		
Alternative Waste Treatment System (RB-5)	System	34		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	21		
	Total Cost	$2,449,530		
Stormwater BMPs				
Bioretention	Acre-Treated	88	315	350
Rain Gardens	Acre-Treated	175	315	350
Infiltration Trench	Acre-Treated	63	225	250
Manufactured BMP	Acre-Treated	125	225	250
Constructed Wetland	Acre-Treated	65	232	258
Detention Pond	Acre-Treated	58	207	230
Riparian Buffer: Forest	Acre-Installed	1	3	5
Riparian Buffer: Grass/Shrub	Acre-Installed	2	4	5
	Total Cost	$5,035,298	$7,012,953	$1,341,320
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed			
Woodland buffer filter area (FR-3)	Acre-Installed	187	561	748
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	1,216	3,647	4,863
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	416	831	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	748
Wet Detention Ponds	Acre-Treated	13	38	50
Grazing Land Management (SL-9)	Acre-Installed	0	0	0
	Total Cost	$3,255,185	$6,427,245	$3,228,170
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	17		
Small Grain Cover Crop (SL-8)	Acre-Treated	17		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	11		
Sod Waterway (WP-3)	Acre-Treated	4		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	4		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	4		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	12		
	Total Cost	$30,130		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	1,163	1,745	2,327
Livestock Exclusion for TMDL IP (SL-6)	Feet	4,596	6,893	9,191
Livestock Exclusion for TMDL IP (LE-1T)	Feet	4,596	6,893	9,191
Small Acreage Grazing System (SL-6AT)	Feet	349	524	698
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	582	873	1,163
Stream Protection/Fencing (WP-2T)	Feet	349	524	698
	Total Cost	$98,963	$49,482	$49,482
Total Cost Per Stage		**$10,872,856**	**$13,493,430**	**$4,618,971**
Bacteria Load Per Stage (cfu/year)		**1.08E+14**	**1.47E+14**	**1.61E+14**

Table 6-17. Stewart Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	30		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	7		
Septic System Installation/Replacement (RB-4)	System	6		
Alternative Waste Treatment System (RB-5)	System	3		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	5		
	Total Cost	$143,760		
Stormwater BMPs				
Bioretention	Acre-Treated	31	113	125
Rain Gardens	Acre-Treated	63	113	125
Infiltration Trench	Acre-Treated	5	18	20
Manufactured BMP	Acre-Treated	10	18	20
Constructed Wetland	Acre-Treated	6	23	25
Detention Pond	Acre-Treated	0	0	0
Riparian Buffer: Forest	Acre-Installed	0.11	0.34	0.45
Riparian Buffer: Grass/Shrub	Acre-Installed	0.22	0.40	0.45
	Total Cost	$80	$64	$16
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	2	5	7
Woodland buffer filter area (FR-3)	Acre-Installed	95	286	381
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	619	1,857	2,476
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	212	423	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	381
Wet Detention Ponds	Acre-Treated	256	769	1,025
Grazing Land Management (SL-9)	Acre-Installed	75	225	300
	Total Cost	$1,813,348	$3,584,375	$1,799,588
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	12		
Small Grain Cover Crop (SL-8)	Acre-Treated	11		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	10		
Sod Waterway (WP-3)	Acre-Treated	2		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	2		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	2		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	10		
	Total Cost	$18,120		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	399	599	798
Livestock Exclusion for TMDL IP (SL-6)	Feet	1,576	2,365	3,153
Livestock Exclusion for TMDL IP (LE-1T)	Feet	1,576	2,365	3,153
Small Acreage Grazing System (SL-6AT)	Feet	120	180	239
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	200	299	399
Stream Protection/Fencing (WP-2T)	Feet	120	180	239
	Total Cost	$33,955	$16,978	$16,978
Total Cost Per Stage		**$2,013,013**	**$3,605,167**	**$1,816,581**
Bacteria Load Per Stage (cfu/year)		**5.22E+13**	**4.19E+13**	**5.18E+13**

Table 6-18. Sugartree Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	17		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	4		
Septic System Installation/Replacement (RB-4)	System	4		
Alternative Waste Treatment System (RB-5)	System	2		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	3		
	Total Cost	$82,270		
Stormwater BMPs				
Bioretention	Acre-Treated	9	32	35
Rain Gardens	Acre-Treated	18	32	35
Infiltration Trench	Acre-Treated	9	32	35
Manufactured BMP	Acre-Treated	15	27	30
Constructed Wetland	Acre-Treated	8	27	30
Detention Pond	Acre-Treated	5	18	20
Riparian Buffer: Forest	Acre-Installed	0	1	1
Riparian Buffer: Grass/Shrub	Acre-Installed	0	1	1
	Total Cost	$569,035	$781,358	$150,477
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	1	2	3
Woodland buffer filter area (FR-3)	Acre-Installed	20	61	82
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	266	799	1,066
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	205	410	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	164
Wet Detention Ponds	Acre-Treated	125	375	500
Grazing Land Management (SL-9)	Acre-Installed	25	75	100
	Total Cost	$790,830	$1,540,670	$762,140
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	1		
Small Grain Cover Crop (SL-8)	Acre-Treated	1		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	1		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	1		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	1		
	Total Cost	$4,480		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	337	505	674
Livestock Exclusion for TMDL IP (SL-6)	Feet	1,331	1,996	2,661
Livestock Exclusion for TMDL IP (LE-1T)	Feet	1,331	1,996	2,661
Small Acreage Grazing System (SL-6AT)	Feet	101	152	202
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	168	253	337
Stream Protection/Fencing (WP-2T)	Feet	101	152	202
	Total Cost	$28,655	$14,328	$14,328
Total Cost Per Stage		**$1,479,020**	**$2,340,106**	**$926,945**
Bacteria Load Per Stage (cfu/year)		**2.96E+13**	**2.76E+13**	**3.02E+13**

Table 6-19. Tanyard Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	100		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	18		
Septic System Installation/Replacement (RB-4)	System	12		
Alternative Waste Treatment System (RB-5)	System	5		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	18		
	Total Cost	$278,190		
Stormwater BMPs				
Bioretention	Acre-Treated	8	27	30
Rain Gardens	Acre-Treated	15	27	30
Infiltration Trench	Acre-Treated	3	9	10
Manufactured BMP	Acre-Treated	5	9	10
Constructed Wetland	Acre-Treated	8	27	30
Detention Pond	Acre-Treated	4	15	17
Riparian Buffer: Forest	Acre-Installed	0.1	0.3	0.4
Riparian Buffer: Grass/Shrub	Acre-Installed	0.2	0.4	0.4
	Total Cost	$303,358	$473,359	$86,554
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed			
Woodland buffer filter area (FR-3)	Acre-Installed	44	133	177
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	528	1,583	2,111
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	93	187	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	355
Wet Detention Ponds	Acre-Treated	0	0	0
Grazing Land Management (SL-9)	Acre-Installed	0	0	0
	Total Cost	$1,369,285	$2,719,895	$1,377,220
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	2		
Small Grain Cover Crop (SL-8)	Acre-Treated	2		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	2		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	1		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	2		
	Total Cost	$6,700		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	742	1,113	1,484
Livestock Exclusion for TMDL IP (SL-6)	Feet	2,930	4,395	5,861
Livestock Exclusion for TMDL IP (LE-1T)	Feet	2,930	4,395	5,861
Small Acreage Grazing System (SL-6AT)	Feet	223	334	445
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	371	556	742
Stream Protection/Fencing (WP-2T)	Feet	223	334	445
	Total Cost	$63,105	$31,553	$31,553
Total Cost Per Stage		**$2,024,388**	**$3,228,557**	**$1,495,326**
Bacteria Load Per Stage (cfu/year)		**5.10E+13**	**2.79E+13**	**3.36E+13**

Table 6-20. Fall Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	127		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	23		
Septic System Installation/Replacement (RB-4)	System	25		
Alternative Waste Treatment System (RB-5)	System	6		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	1		
Pet waste Composter	Unit	23		
	Total Cost	$435,590		
Stormwater BMPs				
Bioretention	Acre-Treated	138	495	550
Rain Gardens	Acre-Treated	275	495	550
Infiltration Trench	Acre-Treated	63	225	250
Manufactured BMP	Acre-Treated	125	225	250
Constructed Wetland	Acre-Treated	138	495	550
Detention Pond	Acre-Treated	25	90	100
Riparian Buffer: Forest	Acre-Installed	2	7	10
Riparian Buffer: Grass/Shrub	Acre-Installed	5	9	10
	Total Cost	$6,128,975	$8,952,106	$1,681,329
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	3	8	10
Woodland buffer filter area (FR-3)	Acre-Installed	64	193	258
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	858	2,573	3,431
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	645	1,290	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	516
Wet Detention Ponds	Acre-Treated	375	1,125	1,500
Grazing Land Management (SL-9)	Acre-Installed	75	225	300
	Total Cost	$2,534,560	$4,940,145	$2,444,275
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	14		
Small Grain Cover Crop (SL-8)	Acre-Treated	15		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	17		
Sod Waterway (WP-3)	Acre-Treated	2		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	2		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	2		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	17		
	Total Cost	$22,830		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	342	513	683
Livestock Exclusion for TMDL IP (SL-6)	Feet	1,350	2,025	2,700
Livestock Exclusion for TMDL IP (LE-1T)	Feet	1,350	2,025	2,700
Small Acreage Grazing System (SL-6AT)	Feet	103	154	205
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	171	256	342
Stream Protection/Fencing (WP-2T)	Feet	103	154	205
	Total Cost	$29,068	$14,534	$14,534
Total Cost Per Stage		**$9,154,773**	**$13,910,535**	**$4,140,138**
Bacteria Load Per Stage (cfu/year)		**9.38E+13**	**7.14E+13**	**8.72E+13**

Table 6-21. Lawless Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	12		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	2		
Septic System Installation/Replacement (RB-4)	System	2		
Alternative Waste Treatment System (RB-5)	System	1		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	2		
	Total Cost	$44,030		
Stormwater BMPs				
Bioretention	Acre-Treated	13	47	52
Rain Gardens	Acre-Treated	13	23	25
Infiltration Trench	Acre-Treated	6	23	25
Manufactured BMP	Acre-Treated	13	23	25
Constructed Wetland	Acre-Treated	13	45	50
Detention Pond	Acre-Treated	13	45	50
Riparian Buffer: Forest	Acre-Installed	0	0	0
Riparian Buffer: Grass/Shrub	Acre-Installed	0	0	0
	Total Cost	$564,095	$903,868	$163,297
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	1	2	3
Woodland buffer filter area (FR-3)	Acre-Installed	30	90	120
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	202	605	807
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	155	310	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	124
Wet Detention Ponds	Acre-Treated	84	253	337
Grazing Land Management (SL-9)	Acre-Installed	13	38	50
	Total Cost	$607,755	$1,184,475	$586,030
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	1		
Small Grain Cover Crop (SL-8)	Acre-Treated	0		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	25		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	2		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	25		
	Total Cost	$16,940		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	18	28	37
Livestock Exclusion for TMDL IP (SL-6)	Feet	72	109	145
Livestock Exclusion for TMDL IP (LE-1T)	Feet	72	109	145
Small Acreage Grazing System (SL-6AT)	Feet	6	8	11
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	9	14	18
Stream Protection/Fencing (WP-2T)	Feet	6	8	11
	Total Cost	$1,561	$781	$781
Total Cost Per Stage		**$1,238,131**	**$2,092,874**	**$750,108**
Bacteria Load Per Stage (cfu/year)		**1.90E+13**	**1.58E+13**	**1.70E+13**

Table 6-22. Double Creek Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	41		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	7		
Septic System Installation/Replacement (RB-4)	System	4		
Alternative Waste Treatment System (RB-5)	System	2		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	7		
	Total Cost	$110,660		
Stormwater BMPs				
Bioretention	Acre-Treated	6	23	25
Rain Gardens	Acre-Treated	13	23	25
Infiltration Trench	Acre-Treated	6	20	22
Manufactured BMP	Acre-Treated	11	20	22
Constructed Wetland	Acre-Treated	6	22	24
Detention Pond	Acre-Treated	0	0	0
Riparian Buffer: Forest	Acre-Installed	0	0	0
Riparian Buffer: Grass/Shrub	Acre-Installed	0	0	0
	Total Cost	$395,510	$519,736	$101,754
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed	0	1	1
Woodland buffer filter area (FR-3)	Acre-Installed	9	27	36
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	9	27	36
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	18	36	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	36
Wet Detention Ponds	Acre-Treated	0	0	0
Grazing Land Management (SL-9)	Acre-Installed	3	8	10
	Total Cost	$47,320	$91,015	$46,385
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	5		
Small Grain Cover Crop (SL-8)	Acre-Treated	5		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	1		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	1		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	1		
	Total Cost	$4,120		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	feet	256	384	512
Livestock Exclusion for TMDL IP (SL-6)	feet	1,012	1,518	2,024
Livestock Exclusion for TMDL IP (LE-1T)	feet	1,012	1,518	2,024
Small Acreage Grazing System (SL-6AT)	feet	77	115	154
Livestock Exclusion with Reduced Setback (LE-2T)	feet	128	192	256
Stream Protection/Fencing (WP-2T)	feet	77	115	154
	Total Cost	$21,789	$10,895	$10,895
Total Cost Per Stage		**$583,149**	**$625,396**	**$159,034**
Bacteria Load Per Stage (cfu/year)		**3.85E+12**	**1.79E+12**	**1.99E+12**

Table 6-23. Byrd's Branch Subwatershed Implementation Staging				
BMPs	**Unit**	**Stage I (Y1-Y6)**	**Stage II (Y7-Y12)**	**Stage III (Y13-Y15)**
Residential BMPs				
Septic System Pump-Out (RB-1)	Pump Out	5		
Sewer Connection (Targeted Areas and RB-2)	System	0		
Repaired Septic System (RB-3)	System	1		
Septic System Installation/Replacement (RB-4)	System	0		
Alternative Waste Treatment System (RB-5)	System	0		
Pet Waste Education Campaign	Program	1		
Pet Waste Station	Unit	0		
Pet waste Composter	Unit	1		
	Total Cost	$9,030		
Stormwater BMPs				
Bioretention	Acre-Treated	3	9	10
Rain Gardens	Acre-Treated	5	9	10
Infiltration Trench	Acre-Treated	3	9	10
Manufactured BMP	Acre-Treated	5	8	9
Constructed Wetland	Acre-Treated	2	5	6
Detention Pond	Acre-Treated	1	4	4
Riparian Buffer: Forest	Acre-Installed	0	0	0
Riparian Buffer: Grass/Shrub	Acre-Installed	0	0	0
	Total Cost	$163,150	$217,190	$42,260
Pasture BMPs				
Manure Storage (WP-4) - Beef	Acre-Installed			
Woodland buffer filter area (FR-3)	Acre-Installed	2	5	6
Vegetative Cover on Critical Areas (SL-11)	Acre-Installed	2	5	6
Reforestation of Erodible Pasture (FR-1)	Acre-Installed	3	6	0
Pasture Management (EQIP 528, SL-10T)	Acre-Installed	0	0	31
Wet Detention Ponds	Acre-Treated	0	0	0
Grazing Land Management (SL-9)	Acre-Installed	0	0	0
	Total Cost	$5,610	$10,590	$7,310
Stream Restoration				
Stream Restoration	Feet	10	20	
Stream Stabilization	Feet	10	20	
	Total Cost	$3,750	$3,750	
Cropland BMPs				
Continuous No-Till (SL-15)	Acre-Treated	9		
Small Grain Cover Crop (SL-8)	Acre-Treated	6		
Permanent Vegetative Cover on Cropland (SL-1)	Acre-Treated	1		
Sod Waterway (WP-3)	Acre-Treated	1		
Cropland Buffer/Field Borders (CP-33 and WQ-1)	Acre-Treated	1		
Vegetative Cover on Critical Areas (SL-11)	Acre-Treated	1		
Reforestation of Erodible Pasture (FR-1)	Acre-Treated	1		
	Total Cost	$4,280		
Livestock Exclusion Systems				
CREP Livestock Exclusion (CRSL-6)	Feet	34	52	69
Livestock Exclusion for TMDL IP (SL-6)	Feet	136	204	272
Livestock Exclusion for TMDL IP (LE-1T)	Feet	136	204	272
Small Acreage Grazing System (SL-6AT)	Feet	10	16	21
Livestock Exclusion with Reduced Setback (LE-2T)	Feet	17	26	34
Stream Protection/Fencing (WP-2T)	Feet	10	16	21
	Total Cost	$2,933	$1,467	$1,467
Total Cost Per Stage		**$188,753**	**$232,997**	**$51,037**
Bacteria Load Per Stage (cfu/year)		**7.60E+11**	**2.44E+11**	**3.72E+11**

6.2 Targeting

Targeting specific locations for BMP implementation is part of staged implementation and can be used as a guide for stakeholders in the implementation process. The identification of focus areas for placement of BMPs that are smaller than the IP subwatersheds allows for more effective use of limited resources. Targeted areas were identified through spatial analysis using the model segments from the original TMDL development and stream network, land use, and watershed inventory GIS layers. Each segment was ranked based on the amounts or numbers of proposed residential on-site sewage disposal BMPs, urban riparian buffer, stormwater BMPs, and livestock exclusion fencing within each modeling segment (Figures 6-1 and 6-2).

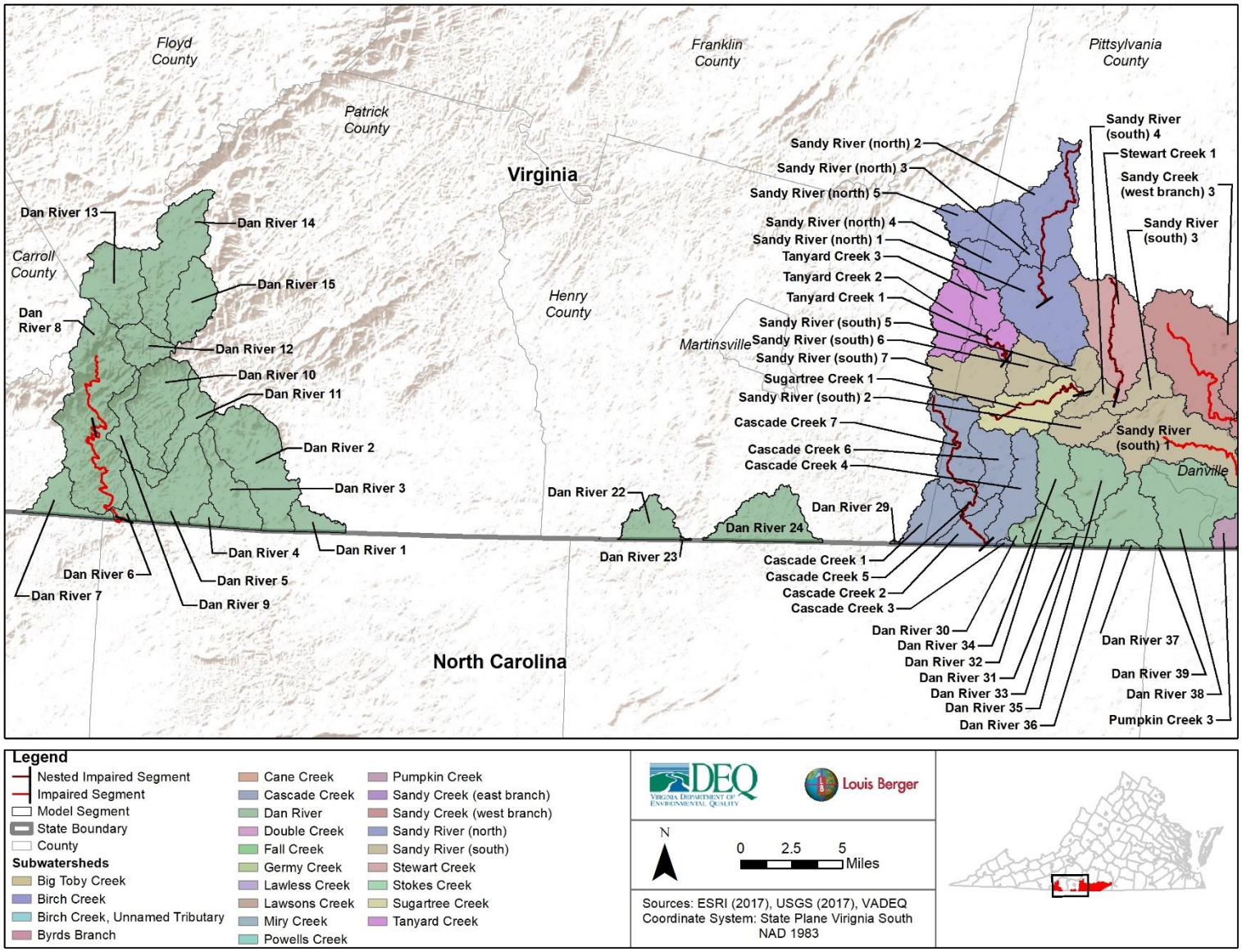

Figure 6-1. Modeling Segments for Targeting Analyses (Western Part)

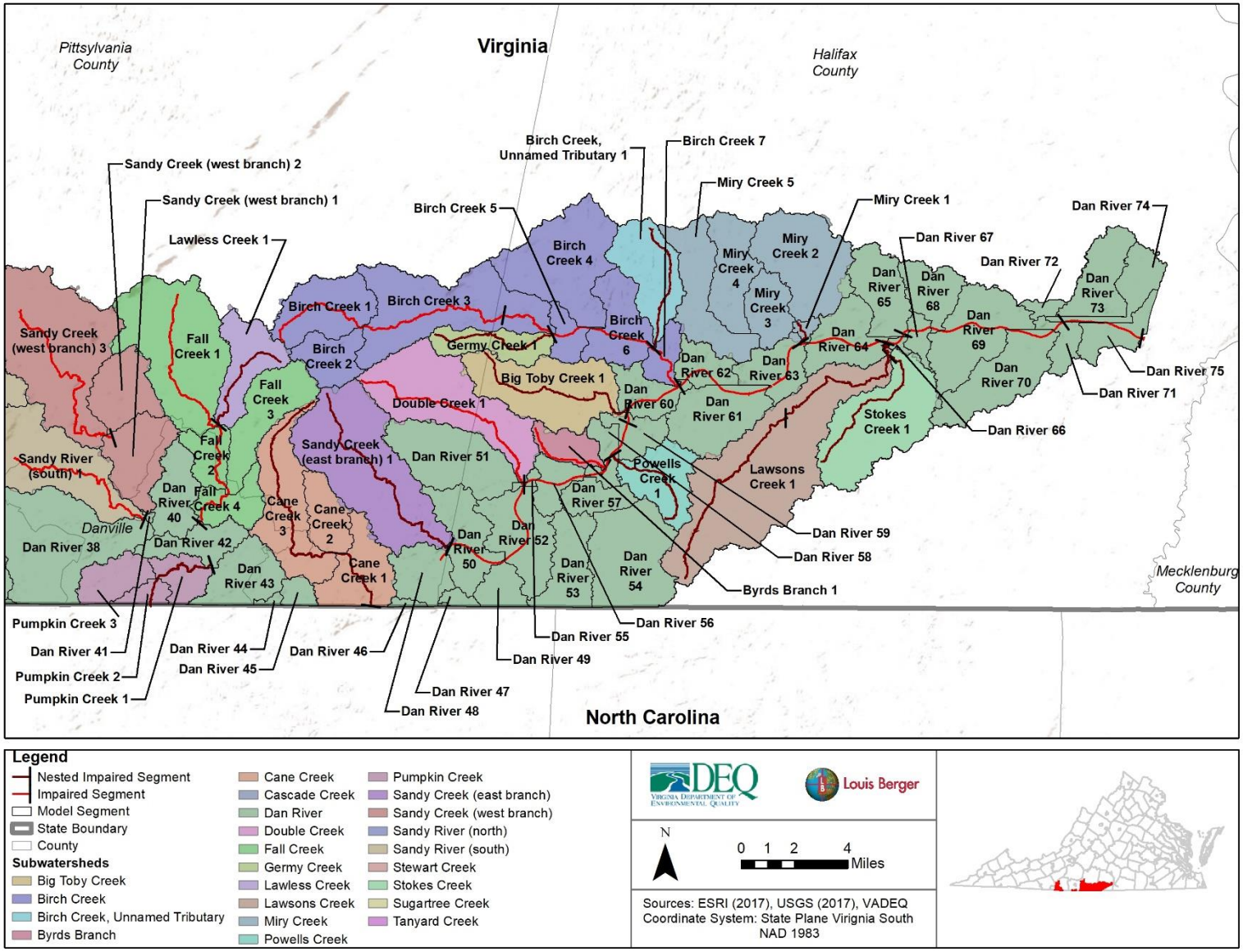

Figure 6-2. Modeling Segments for Targeting Analyses (Eastern Part)

The first BMP analyzed for was residential on-site sewage disposal. Table 6-24 shows the model segments within each subwatershed ranked according to potential implementation priority. The ranks were derived from the number of failing septic systems to be corrected in each model segment and the potential sewer connections from targeted areas (see Section 5.2.2.1) (Table 6-24).

Table 6-24. Targeting of Model Segments for Residential On-Site Sewage Disposal BMPs

Model Segment	Rank	Model Segment	Rank
Dan River 38	1	Sugartree Creek 1	35
Sandy Creek (west) 1	2	Dan River 51	36
Pumpkin Creek 3	3	Sandy River (south) 7	37
Sandy River (south) 1	4	Sandy River (north) 5	38
Dan River 43	5	Dan River 42	39
Cane Creek 3	6	Miry Creek 2	40
Dan River 68	7	Dan River 54	41
Pumpkin Creek 1	8	Cascade Creek 1	42
Pumpkin Creek 2	9	Dan River 22	43
Fall Creek 1	10	Tanyard Creek 2	44
Sandy Creek (west) 3	11	Cascade Creek 6	45
Sandy Creek (west) 2	12	Stokes Creek 1	46
Sandy Creek (east) 1	13	Big Toby Creek 1	47
Dan River 47	14	Dan River 14	48
Dan River 69	15	Birch Creek, Unnamed Tributary 1	49
Dan River 40	16	Birch Creek 1	50
Sandy River (north) 1	17	Fall Creek 4	51
Stewart Creek 1	18	Sandy River (south) 6	52
Lawsons Creek 1	19	Dan River 48	53
Dan River 8	20	Dan River 32	54
Dan River 2	21	Sandy River (north) 4	55
Dan River 36	22	Cascade Creek 2	56
Cane Creek 2	23	Dan River 52	57
Double Creek 1	24	Dan River 13	58
Cascade Creek 7	25	Dan River 5	59
Birch Creek 3	26	Birch Creek 6	60
Dan River 35	27	Fall Creek 2	61
Sandy River (north) 2	28	Tanyard Creek 3	62
Fall Creek 3	29	Dan River 61	63
Dan River 34	30	Sandy River (south) 2	64
Cascade Creek 4	31	Dan River 10	65

Table 6-24. Targeting of Model Segments for Residential On-Site Sewage Disposal BMPs			
Model Segment	**Rank**	**Model Segment**	**Rank**
Dan River 3	32	Dan River 50	66
Birch Creek 4	33	Sandy River (south) 3	67
Lawless Creek 1	34	Powells Creek 1	68
Dan River 15	69	Dan River 75	102
Miry Creek 5	70	Dan River 30	103
Dan River 70	71	Dan River 62	104
Cane Creek 1	72	Dan River 59	105
Tanyard Creek 1	73	Byrds Branch 1	106
Dan River 53	74	Sandy River (north) 3	107
Dan River 73	75	Dan River 58	108
Dan River 64	76	Dan River 71	109
Sandy River (south) 5	77	Dan River 67	110
Birch Creek 2	78	Dan River 37	111
Dan River 1	79	Dan River 44	112
Germy Creek 1	80	Dan River 72	113
Miry Creek 4	81	Dan River 6	114
Dan River 45	82	Cascade Creek 3	115
Sandy River (south) 4	83	Miry Creek 1	116
Dan River 65	84	Dan River 55	117
Dan River 9	85	Dan River 41	118
Dan River 12	86	Dan River 31	119
Cascade Creek 5	87	Dan River 66	120
Dan River 63	88	Dan River 25	121
Dan River 7	89	Dan River 39	122
Dan River 11	90	Dan River 16	123
Dan River 46	91	Dan River 17	124
Dan River 33	92	Dan River 27	125
Miry Creek 3	93	Dan River 19	126
Dan River 60	94	Dan River 20	127
Dan River 57	95	Dan River 18	128
Dan River 4	96	Dan River 29	129
Dan River 74	97	Dan River 21	130
Birch Creek 7	98	Dan River 23	131
Dan River 49	99	Dan River 24	132
Birch Creek 5	100	Dan River 26	133
Dan River 56	101	Dan River 28	134

The second targeting analysis was based on the estimated length of riparian buffer creation in urban areas. Riparian buffer width was not considered in this analysis. Not all model segments contained streams through urban areas that needed riparian buffer creation. The segments are ranked by the total length of urban riparian buffer proposed in each segment (Table 6-25). Figures 6-3 and 6-4 show the potential urban riparian zone creation opportunities in all subwatersheds.

Table 6-25. Spatial Targeting of Urban Riparian Buffer Creation			
Model Segment	**Rank**	**Model Segment**	**Rank**
Pumpkin Creek 3	1	Dan River 70	35
Dan River 65	2	Dan River 4	36
Dan River 13	3	Sugartree Creek 1	37
Dan River 14	4	Miry Creek 5	38
Fall Creek 2	5	Sandy Creek (west) 3	39
Dan River 5	6	Cascade Creek 2	40
Dan River 40	7	Cane Creek 2	41
Dan River 42	8	Cascade Creek 1	42
Pumpkin Creek 1	9	Sandy River (south) 7	43
Dan River 8	10	Powells Creek 1	44
Dan River 48	11	Dan River 62	45
Dan River 73	12	Sandy River (south) 3	46
Dan River 7	13	Cascade Creek 4	47
Dan River 11	14	Dan River 53	48
Dan River 38	15	Dan River 69	49
Dan River 15	16	Stewart Creek 1	50
Sandy Creek (west) 1	17	Sandy Creek (east) 1	51
Dan River 2	18	Sandy River (north) 2	52
Fall Creek 1	19	Dan River 68	53
Dan River 50	20	Dan River 54	54
Dan River 10	21	Dan River 56	55
Sandy River (south) 1	22	Lawless Creek 1	56
Dan River 3	23	Dan River 67	57
Birch Creek 4	24	Fall Creek 4	58
Sandy Creek (west) 2	25	Cane Creek 1	59
Stokes Creek 1	26	Tanyard Creek 2	60
Lawsons Creek 1	27	Dan River 34	61
Dan River 24	28	Dan River 52	62
Cane Creek 3	29	Tanyard Creek 1	63
Dan River 61	30	Dan River 75	64
Dan River 51	31	Big Toby Creek 1	65
Dan River 9	32	Double Creek 1	66
Fall Creek 3	33	Pumpkin Creek 2	67
Dan River 36	34	Miry Creek 2	68

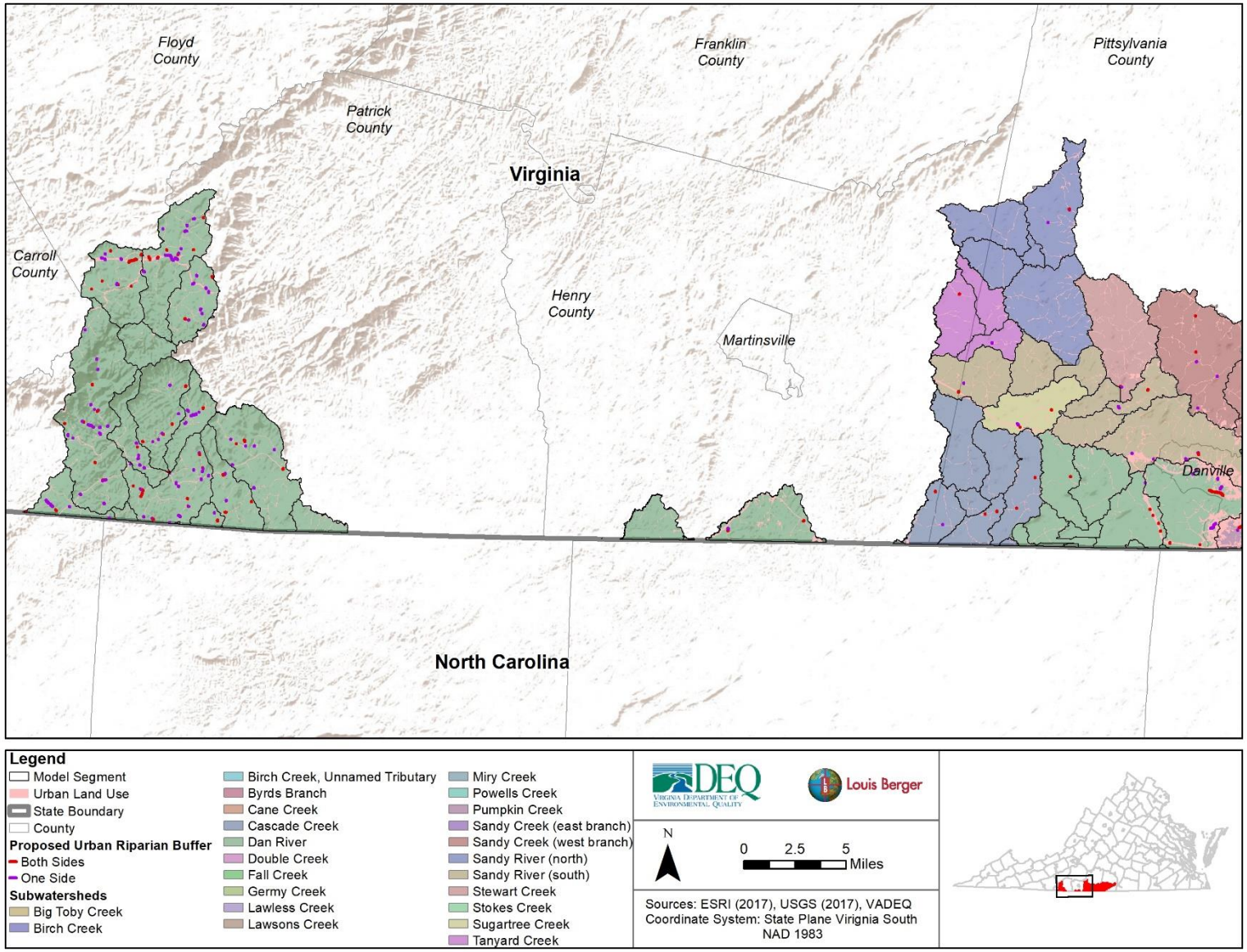

Figure 6-2. Proposed Urban Riparian Buffer Creation by Segment (Western Part)

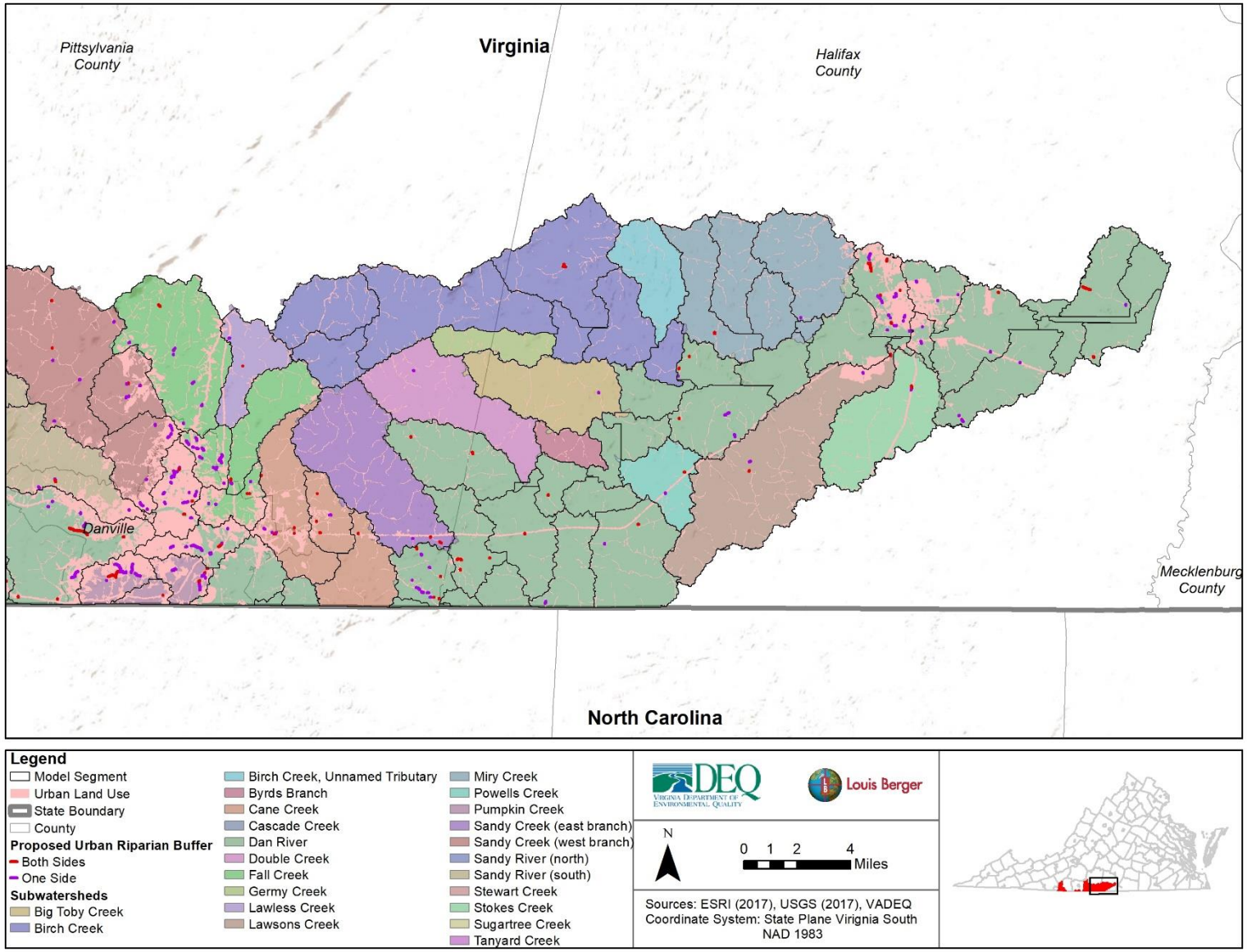

Figure 6-3. Proposed Urban Riparian Buffer Creation by Segment (Eastern Part)

Urban land is a large contributor to bacteria loading. Therefore, stormwater BMPs could maximize bacteria reductions in the areas with the most urban land. Table 6-26 ranks the model segments by the density of urban land; the greater the density of urban land would likely require the more coverage by stormwater BMPs. Figures 6-5 and 6-6 present the spatial distribution of the urban land use in all subwatersheds.

Table 6-26. Spatial Targeting of Urbanized Model Segments for Implementation of Stormwater BMPs

Model Segment	Rank	Model Segment	Rank
Dan River 40	1	Dan River 24	32
Dan River 41	2	Lawless Creek 1	33
Dan River 21	3	Dan River 64	34
Dan River 42	4	Sandy River (south) 3	35
Pumpkin Creek 3	5	Dan River 13	36
Dan River 65	6	Lawsons Creek 1	37
Fall Creek 4	7	Fall Creek 3	38
Fall Creek 2	8	Dan River 39	39
Dan River 67	9	Dan River 17	40
Pumpkin Creek 1	10	Dan River 45	41
Dan River 28	11	Dan River 15	42
Dan River 68	12	Dan River 1	43
Dan River 27	13	Dan River 48	44
Sandy Creek (west) 1	14	Dan River 36	45
Dan River 16	15	Stokes Creek 1	46
Dan River 18	16	Sandy River (south) 2	47
Pumpkin Creek 2	17	Sandy River (south) 7	48
Dan River 38	18	Sugartree Creek 1	49
Sandy Creek (west) 2	19	Dan River 7	50
Dan River 26	20	Stewart Creek 1	51
Dan River 66	21	Dan River 14	52
Dan River 43	22	Miry Creek 2	53
Dan River 25	23	Dan River 53	54
Dan River 29	24	Birch Creek 1	55
Cane Creek 3	25	Sandy Creek (west) 3	56
Sandy River (south) 1	26	Cane Creek 1	57
Fall Creek 1	27	Powells Creek 1	58
Cane Creek 2	28	Dan River 70	59
Dan River 20	29	Dan River 61	60
Dan River 19	30	Dan River 50	61
Dan River 69	31	Dan River 5	62

Table 6-26. Spatial Targeting of Urbanized Model Segments for Implementation of Stormwater BMPs

Model Segment	Rank	Model Segment	Rank
Sandy Creek (east) 1	63	Dan River 63	99
Dan River 9	64	Miry Creek 1	100
Dan River 54	65	Big Toby Creek 1	101
Byrds Branch 1	66	Cascade Creek 4	102
Dan River 6	67	Dan River 56	103
Sandy River (north) 2	68	Birch Creek 4	104
Birch Creek 2	69	Double Creek 1	105
Miry Creek 4	70	Tanyard Creek 2	106
Sandy River (south) 5	71	Tanyard Creek 3	107
Dan River 51	72	Birch Creek 6	108
Sandy River (south) 6	73	Dan River 62	109
Germy Creek 1	74	Dan River 22	110
Sandy River (north) 1	75	Birch Creek, Unnamed Tributary 1	111
Cascade Creek 3	76	Birch Creek 5	112
Dan River 52	77	Dan River 75	113
Dan River 35	78	Dan River 55	114
Dan River 11	79	Dan River 57	115
Cascade Creek 2	80	Dan River 32	116
Miry Creek 5	81	Dan River 73	117
Tanyard Creek 1	82	Dan River 37	118
Birch Creek 3	83	Dan River 34	119
Dan River 4	84	Dan River 58	120
Dan River 71	85	Cascade Creek 6	121
Dan River 44	86	Birch Creek 7	122
Dan River 49	87	Dan River 10	123
Cascade Creek 1	88	Dan River 46	124
Sandy River (south) 4	89	Dan River 60	125
Dan River 59	90	Dan River 47	126
Miry Creek 3	91	Cascade Creek 7	127
Sandy River (north) 5	92	Sandy River (north) 4	128
Dan River 2	93	Sandy River (north) 3	129
Dan River 8	94	Dan River 30	130
Dan River 3	95	Dan River 12	131
Cascade Creek 5	96	Dan River 74	132
Dan River 72	97	Dan River 33	133
Dan River 23	98		

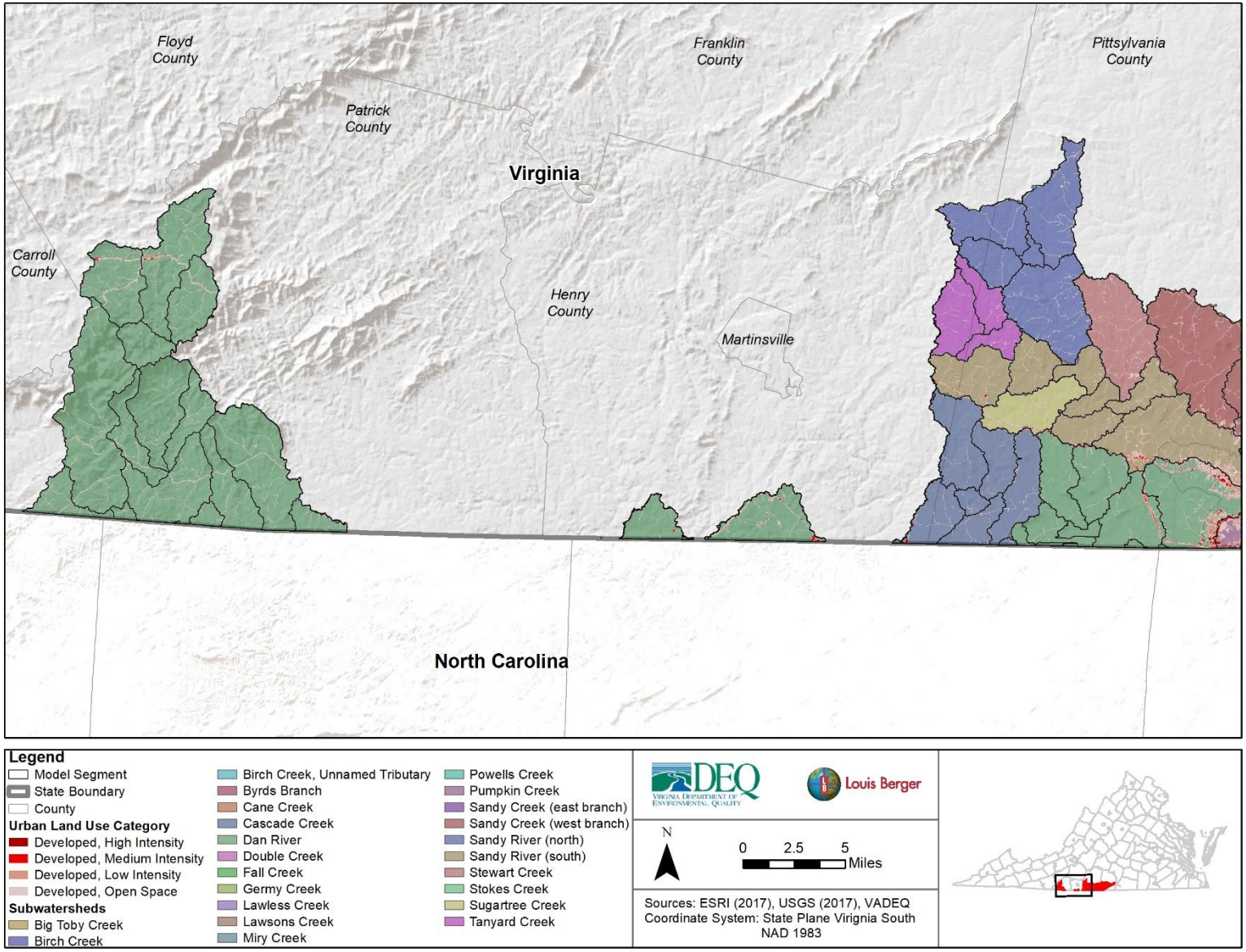

Figure 6-4. Urban Area Density by Segment (Western Part)

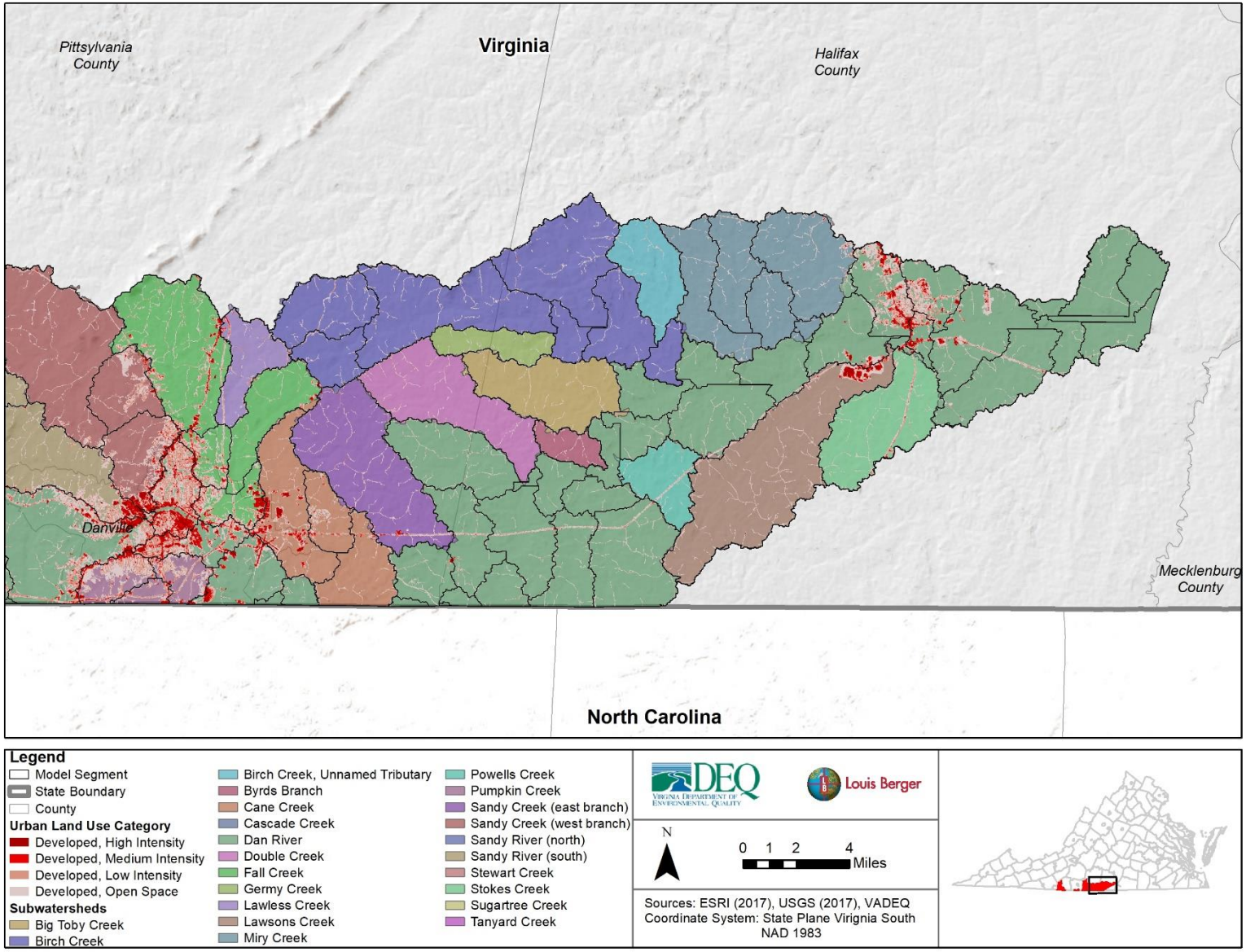

Figure 6-5. Urban Area Density by Segment (Eastern Part)

Livestock exclusion practices are an effective method to reduce bacteria in the watershed. Livestock exclusion practices were not proposed for all segments; therefore, only segments containing proposed livestock exclusion were ranked. Table 6-27 ranks each model segment by the total length of livestock stream fencing proposed within the segment. Figures 6-7 and 6-8 show the proposed livestock exclusion stream fencing.

Table 6-27. Spatial Targeting of Livestock Stream Fencing

Model Segment	Rank	Model Segment	Rank
Dan River 13	1	Dan River 36	31
Dan River 48	2	Dan River 24	32
Dan River 14	3	Cascade Creek 7	33
Lawsons Creek 1	4	Cascade Creek 1	34
Dan River 8	5	Cascade Creek 4	35
Dan River 5	6	Dan River 38	36
Dan River 2	7	Fall Creek 1	37
Dan River 50	8	Double Creek 1	38
Dan River 15	9	Tanyard Creek 3	39
Big Toby Creek 1	10	Sandy River (north) 1	40
Sandy Creek (west) 3	11	Dan River 69	41
Dan River 7	12	Sandy River (south) 3	42
Dan River 3	13	Dan River 62	43
Dan River 35	14	Dan River 47	44
Sandy River (north) 2	15	Dan River 11	45
Sandy River (south) 7	16	Dan River 70	46
Dan River 43	17	Cane Creek 1	47
Sandy River (north) 5	18	Dan River 58	48
Dan River 10	19	Stokes Creek 1	49
Miry Creek 5	20	Dan River 1	50
Dan River 73	21	Dan River 56	51
Tanyard Creek 2	22	Dan River 61	52
Sandy River (south) 1	23	Miry Creek 3	53
Stewart Creek 1	24	Birch Creek 6	54
Powells Creek 1	25	Sandy Creek (east) 1	55
Cane Creek 3	26	Dan River 52	56
Dan River 54	27	Birch Creek 4	57
Dan River 9	28	Miry Creek 2	58
Sugartree Creek 1	29	Sandy River (south) 5	59
Sandy Creek (west) 2	30	Dan River 60	60
Cascade Creek 2	61	Dan River 75	79
Birch Creek 7	62	Sandy River (south) 6	80

Table 6-27. Spatial Targeting of Livestock Stream Fencing			
Model Segment	**Rank**	**Model Segment**	**Rank**
Dan River 63	63	Byrds Branch 1	81
Dan River 4	64	Sandy River (south) 4	82
Birch Creek, Unnamed Tributary 1	65	Cascade Creek 5	83
Miry Creek 4	66	Sandy Creek (west) 1	84
Dan River 68	67	Dan River 42	85
Cane Creek 2	68	Dan River 46	86
Fall Creek 3	69	Dan River 32	87
Cascade Creek 6	70	Lawless Creek 1	88
Dan River 51	71	Dan River 74	89
Dan River 34	72	Dan River 71	90
Dan River 22	73	Dan River 59	91
Pumpkin Creek 2	74	Sandy River (north) 4	92
Sandy River (south) 2	75	Germy Creek 1	93
Dan River 53	76	Dan River 6	94
Dan River 45	77	Dan River 67	95
Tanyard Creek 1	78	Pumpkin Creek 1	96

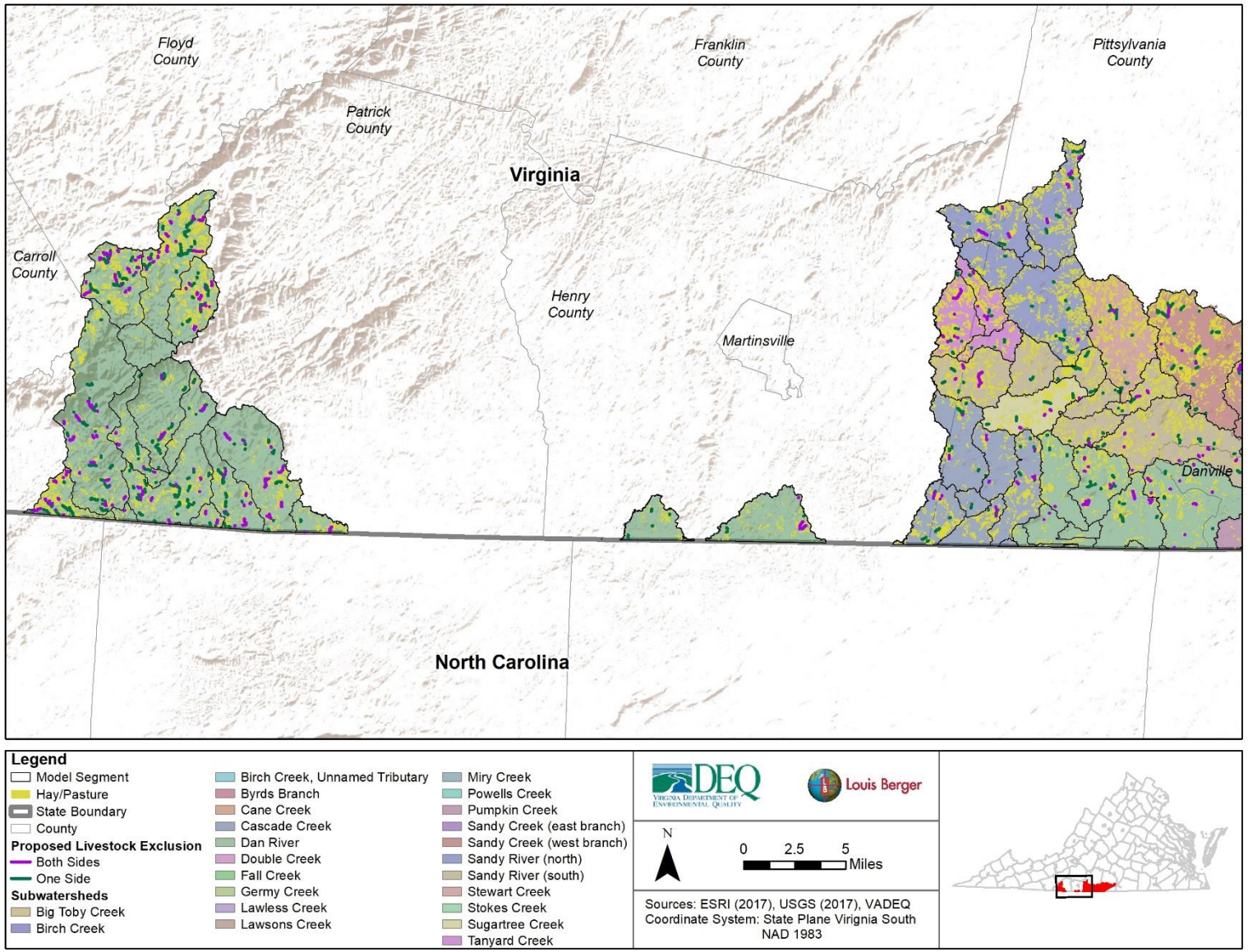

Figure 6-6. Proposed Livestock Exclusion by Segment (Western Part)

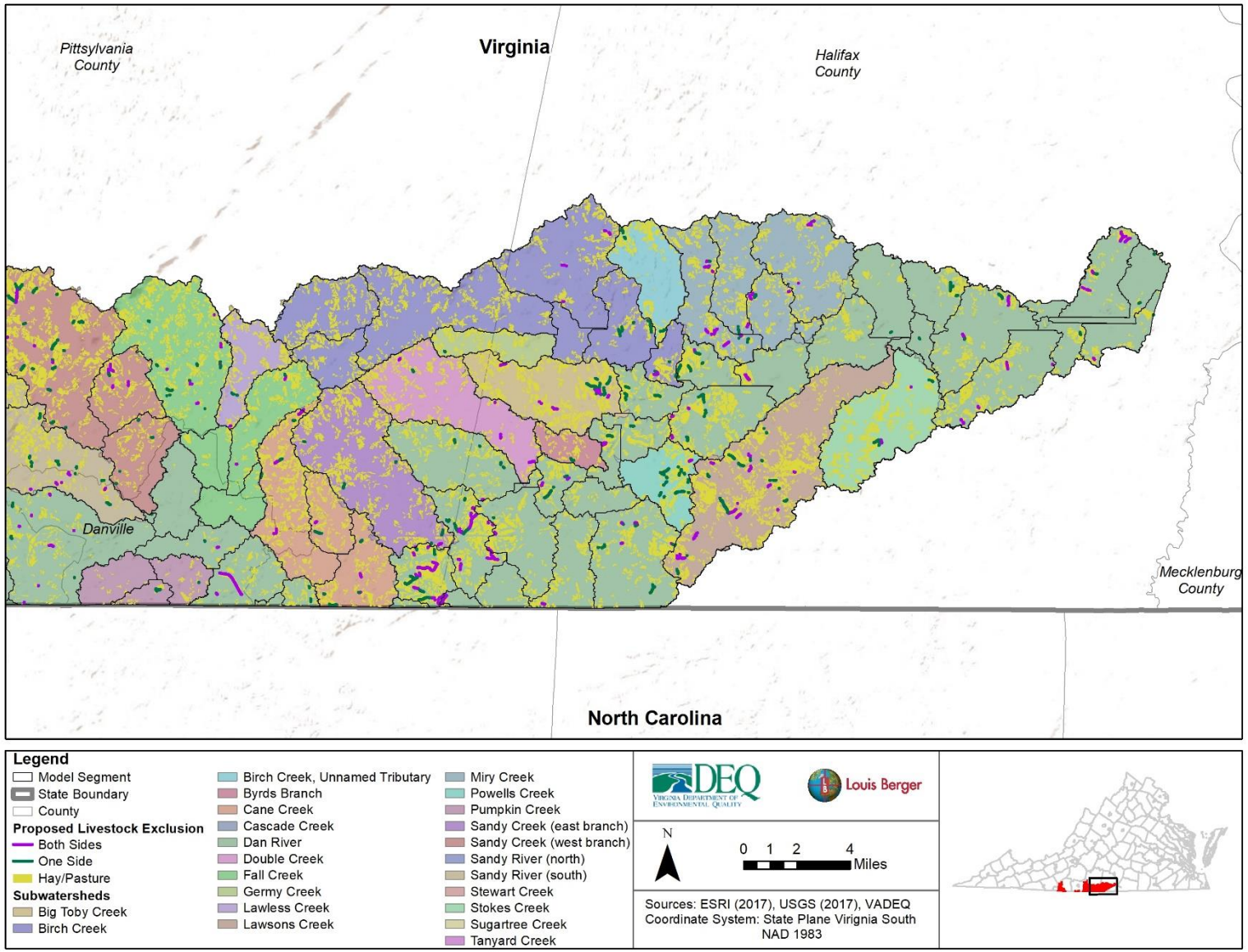

Figure 6-7. Proposed Livestock Exclusion by Segment (Eastern Part)

6.3 Reasonable Assurance

An important part of the IP process is to solicit information and the experiences of the stakeholders and to assess the proposed BMPs, educational programs, and other practices. Many of the actions are voluntary, so acceptance from the public is crucial to the success of the IP and eventual implementation of the BMPs. Throughout the IP process, the major stakeholders and a variety of local conservation agency personnel participated in public meetings, working groups, and steering committees. They provided feedback, information, and expertise, including about proposed BMPs, both in-person and through emails. Stakeholder input on watershed conditions, existing and preferred BMPs, and BMP implementation capability was incorporated into the IP, providing reasonable assurance that the proposed implementation actions will occur and that allocated bacteria loads will be met.

6.4 Implementation Tracking

Implementation actions should be tracked to ensure that BMPs are adequately installed and maintained. Implementation tracking involves inventorying the locations of and the numbers of BMPs put into place within the watershed and will be used to evaluate changes in the watershed. BMP tracking will include the quantification of the various BMPs identified in the IP and reporting the applicable units that are installed in each subwatershed. Management measures, such as types of outreach education activities (e.g., workshops, mailings, field days) and number of participants should also be tracked. The agricultural practices that use cost-share funding will be tracked through the local Soil and Water Conservation Districts and will be incorporated into the Virginia Agricultural Cost-share Database, administered by VADCR. Tracking of stormwater BMPs will occur on a municipality level. A subset of the IP steering committee may want to reconvene and collaborate on implementation tracking at key points throughout the implementation timeline.

6.5 Monitoring Plan

Monitoring the water quality of the impaired watersheds will occur throughout the timeline of the IP to evaluate progress toward meeting water quality milestones and toward implementing the proposed BMPs. Since the primary goal of the IP is to de-list the impaired segments for bacteria, VADEQ will focus its monitoring efforts on the original listing stations (Table 6-28,

Figure 6-9). VADEQ-supported monitoring will occur at these and/or additional stations in the IP area after a period of at least two years of BMP installation in a particular subwatershed. Key stakeholders may convene with VADEQ to discuss monitoring start times and implementation activities. Monitoring at bacteria stations may occur on a bi-monthly cycle, typically in the spring and fall. Additional monitoring could be scheduled if VADEQ is unable to de-list the impaired segments for bacteria.

Table 6-28. Bacteria Monitoring Stations			
Watershed Code	**Station ID**	**Station Description**	**Stream Name**
VAC-L63R	4ABIR001.00	Rt. 659 Bridge	Birch Creek
VAC-L62R	4ABTC000.60	Big Toby Creek @ Rt. 691	Big Toby Creek
VAC-L62R	4ABYR002.13	Byrds Branch @ Rt. 689	Byrds Branch
VAC-L62R	4ABYR000.08	Byrds Branch @ the end of Rt. 810	Byrds Branch
VAC-L60R	4ACAN000.80	Cane Creek @ Cedar Rd (NC Rte. 1530)	Cane Creek
VAC-L57R	4ACAS001.92	Rt. 860 near state line	Cascade Creek
VAC-L64R	4ADAN015.30	Rt. 501 below South Boston	Dan River
VAC-L62R	4ADAN028.90	Rt. 658 at Paces	Dan River
VAC-L60R	4ADAN042.80	Rt. 62 at VA - NC state line	Dan River
VAC-L60R	4ADAN053.40	Bridge located at Danville STP	Dan River
VAC-L57R	4ADAN075.22	Rt. 880 Bridge at state line	Dan River
VAC-L62R	4ADBC002.19	Double Creek, Rt. 688 Bridge	Double Creek
VAW-L61R	4AFAL001.58	Fall Cr @ Rt. 730	Fall Creek
VAC-L63R	4AGER001.17	Germy Creek @ Rt. 820	Germy Creek
VAC-L61R	4ALAW002.43	Lawless Creek @ Lawless Creek Rd	Lawless Creek
VAC-L64R	4ALSN007.45	Lawsons Creek @ Rt. 708 bridge	Lawsons Creek
VAC-L64R	4AMRY000.82	Miry Creek @ River Rd (Rt. 659)	Miry Branch
VAC-L60R	4APKP002.31	Pumpkin Creek, old Rt. 86	Pumpkin Creek
VAC-L62R	4APOW000.69	Powells Creek @ Rt. 751	Powells Creek
VAC-L59R	4ASCR007.06	Rt. 746 Bridge	Sandy Creek
VAC-L64R	4ASKS002.80	Stokes Creek @ Rt. 704	Stokes Creek
VAC-L62R	4ASLC002.75	Rt. 655 Bridge, Pittsylvania	Sandy Creek
VAC-L58R	4ASRV000.20	Route 58 Bridge, Danville – City of Danville	Sandy River
VAC-L58R	4ASRV022.99	Sandy River @ Wyatt Farm Road Rt. 612	Sandy River
VAC-L58R	4ASRV025.40	Sandy River @ Mapleton Rd.	Sandy River
VAC-L58R	4ASSP002.44	Rt. 841, Whispering Pines Road	Sandy River, South Prong
VAC-L58R	4ASUT000.89	Sugartree Creek @ Inman Rd	Sugartree Creek
VAC-L58R	4ATRD000.04	Tanyard Creek, Rt. 855 in Soap Stone	Tanyard Creek
VAC-L60R	4ASWA002.97	Stewart Creek @ Rte 882	Stewart Creek
VAW-L42R	4ADAN181.10	Rt. 648 Bridge near Kibler	Dan River

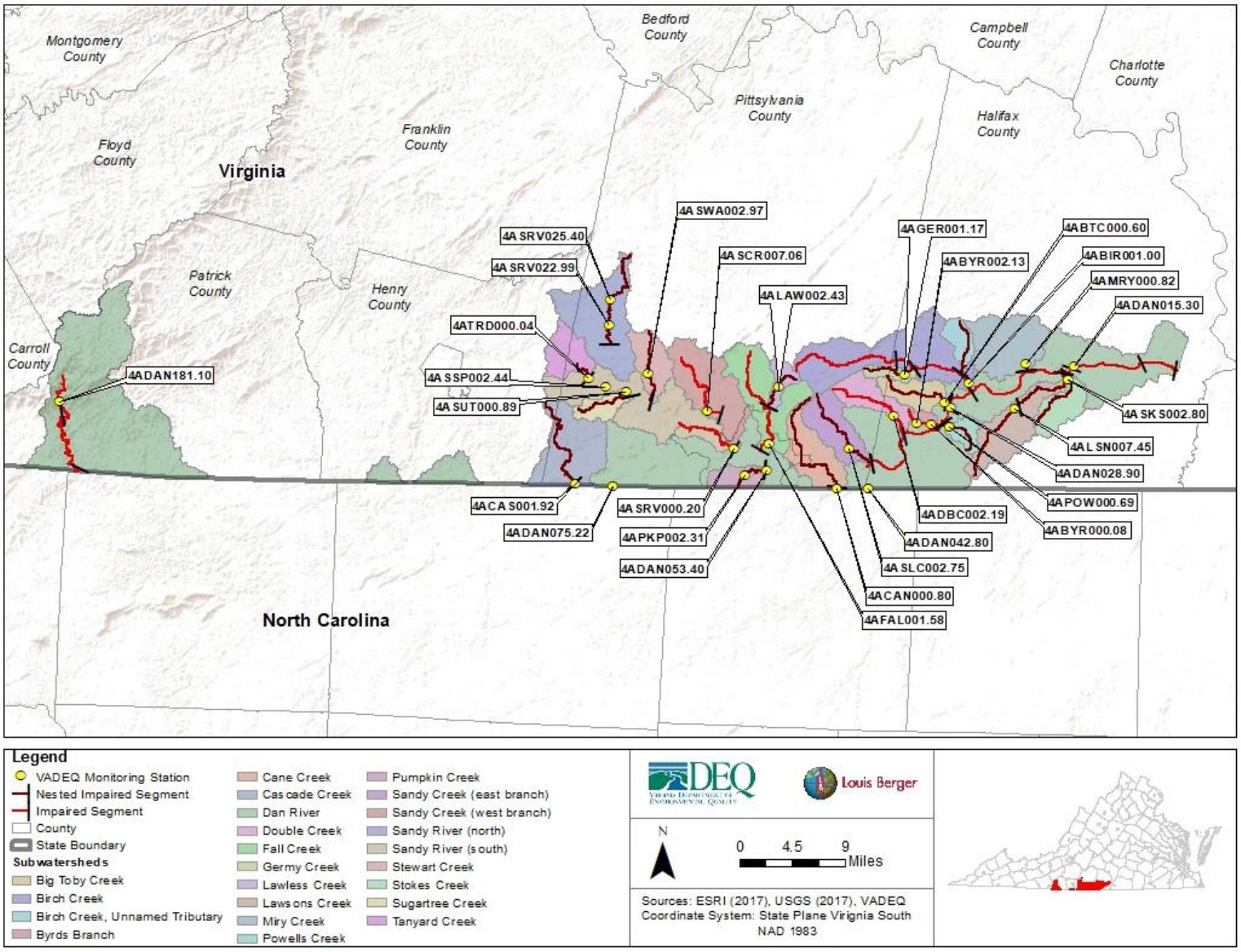

Figure 6-8. Monitoring Stations

7.0 Stakeholders' Roles and Responsibilities

Stakeholders are individuals or groups who live or have land management responsibilities in the watershed. These stakeholders include federal, state, and local government agencies; businesses; special interest groups; and citizens. Stakeholder participation and support is essential for improving water quality and removing streams from the impaired waters list. The purpose of this chapter is to acknowledge the roles of the stakeholders who worked together to develop the Birch Creek and Dan River TMDL IP and to identify and define the roles and responsibilities many of these stakeholders will play in the implementation of the control measures described in the IP.

7.1 Federal Government

U.S. Environmental Protection Agency (EPA): **EPA** has the responsibility of overseeing the various programs necessary for the success of the CWA. However, administration and enforcement of such programs falls largely to the states. Section 303(d) of the CWA and current EPA regulations do not require the development of TMDL IPs. EPA has outlined nine minimum elements of an approvable IP for states to receive Section 319 funding for IP development and implementation.

Natural Resources Conservation Service (NRCS): **NRCS**, as part of the U.S. Department of Agriculture, works closely with the American people to conserve natural resources on private lands. NRCS assists private landowners with conserving their soil, water, and other natural resources. Local, state, and federal agencies and policymakers also rely on the expertise of NRCS staff. NRCS is a major funding stakeholder for impaired waterbodies through the Environmental Quality Incentive Program (EQIP). For more information on NRCS, visit *http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/*.

7.2 State Government

In the Commonwealth of Virginia, water quality problems are dealt with through legislation, incentive programs, education, and legal actions. Currently, there are six state agencies that have a major role in regulating and/or overseeing statewide activities that impact water quality in Virginia. These agencies include: Virginia Department of Environmental Quality (VADEQ),

Virginia Department of Conservation and Recreation (VADCR), Virginia Department of Agriculture and Consumer Services (VDACS), Virginia Department of Health (VDH), Virginia Department of Forestry (VDOF), and Virginia Cooperative Extension (VCE). VADEQ, VADCR, VCE, and VDH have participated in the Birch Creek and Dan River TMDL IP development process through meeting attendance, comments and suggestions on various aspects of the plan, and/or through provision of watershed and water quality data.

Virginia Department of Environmental Quality (VADEQ): **VADEQ** is the lead agency in the TMDL process. The Code of Virginia (62.1-44.19:5) directs VADEQ to develop a list of impaired waters, develop TMDLs for these waters, and develop IPs for the TMDLs. VADEQ administers the TMDL process, including the public participation component, and formally submits the TMDLs and IPs to EPA and the State Water Control Board for approval. The agency has a role in working with local agency partners to track implementation progress for control measures identified in the IP. VADEQ also provides available grant funding and technical support for TMDL implementation including regional staff who work with interested partners on grant proposals to generate funds for implementation. VADEQ is responsible for assessing water quality to determine compliance with water quality standards. VADEQ will continue monitoring water quality in the Birch Creek, Dan River, and tributaries in order to determine when water quality standards are attained and the streams can be removed from Virginia's impaired water list. More information on VADEQ is available at *http://www.deq.virginia.gov/*.

Virginia Department of Conservation and Recreation (VADCR): **VADCR** administers the Virginia Agricultural Cost Share Program, working closely with Soil and Water Conservation Districts to provide cost share and operating grants needed to deliver this program at the local level and track BMP implementation. In addition, VADCR administers the state's Nutrient Management Program, which provides technical assistance to producers for appropriate storage and applications of manure and commercial fertilizer. More information on VADCR water quality programs is available at *http://www.dcr.virginia.gov/soil_and_water/*.

Virginia Department of Agriculture and Consumer Services (VDACS): **VDACS** administers the Agricultural Stewardship Act and with the local soil and water district investigates and reviews claims that an agricultural producer is causing a water quality problem. Examples include

sediment erosion and runoff containing nutrients and pesticides. If a problem is uncovered, the Commissioner can order the producer to submit an agricultural stewardship plan to the local soil and water conservation district. If a producer fails to implement the plan, corrective action can be taken, which may include civil penalties. The Commissioner of Agriculture can issue an emergency corrective action if runoff is likely to endanger public health, animals, fish and aquatic life, public water supply, etc. An emergency order can shut down all or part of an agricultural activity and require specific stewardship measures. Although complaint-driven, the Agricultural Stewardship Act is considered a regulatory tool that can support the implementation of conservation practices to address pollutant sources in impaired watersheds. More information on VDACS is available at *http://www.vdacs.virginia.gov/conservation-and-environmental-agricultural-stewardship.shtml*.

Virginia Department of Health (VDH): **VDH** is responsible for adopting and implementing regulations for onsite wastewater treatment and disposal. VDH has the responsibility of enforcing actions to correct failed septic systems and/or eliminate straight pipes (Sewage Handling and Disposal Regulations, 12 VAC 5-610-10 *et seq*.). Homeowners are required to secure permits for handling and disposal of sewage (e.g., repairing a failing septic system or installing a new treatment system). VDH staff provide technical assistance to homeowners with septic system maintenance, design and installation, and respond to complaints regarding failing septic systems and straight pipes. The localities included in this IP are served by the Mount Rogers, New River, Pittsylvania/Danville, Southside, and West Piedmont Health Districts. More information on VDH programs is available at *http://www.vdh.state.va.us/EnvironmentalHealth/Onsite/index.htm*.

Virginia Department of Forestry (VDOF): **VDOF** water quality inspectors assist loggers and landowners with timber harvest planning and execution and encourage the use of specific voluntary best management practices to keep streams free of silvicultural sediments. If loggers fail to apply necessary BMPs on harvest sites, sediment deposition may occur, and that can lead to civil penalties under the Virginia Silvicultural Water Quality Law (10.1-1181.2). The VDOF has prepared a manual to inform and educate forest landowners and the professional forest community on proper BMPs and technical specifications for installation of these practices in forested areas (*http://www.dof.virginia.gov/infopubs/BMP-Technical-Guide_pub.pdf*). VDOF

also has a major role in protecting watersheds through riparian forest buffers. Forest buffers provide nutrient uptake and soil stabilization services, which can benefit water quality by reducing the amount of nutrients and sediments that enter local streams. VDOF administers several cost-share programs including the Reforestation of Timberlands (RT) Program, which provides financial assistance to private landowners and the forest industry for pine reforestation. More information on VDOF programs is available at *http://www.dof.virginia.gov/water/index.htm*.

Virginia Cooperative Extension (VCE): **VCE** is an educational outreach program of Virginia's land grant universities (Virginia Tech and Virginia State University), and a part of the national Cooperative State Research, Education, and Extension Service, an agency of the U.S. Department of Agriculture. VCE is a product of cooperation among local, state, and federal governments in partnership with citizens. VCE offers educational programs and technical resources for topics such as crops, grains, livestock, poultry, dairy, natural resources, and environmental management. VCE has several publications that deal specifically with TMDLs. More information on these publications and the location of county extension offices is available at *http://ext.vt.edu/*.

Virginia Department of Transportation (VDOT): **VDOT** has prepared a manual to provide guidance in the design of BMPs for water quality control and stormwater management related to VDOT projects and facilities. In addition, VDOT participates in educating the public on the protection of state waters, stormwater pollution prevention, and their MS4 program. More information and resources on VDOT stormwater programs is available at *http://www.virginiadot.org/business/locdes/ms4_stormwater_management.asp*. The VDOT BMP Design Manual is available at *http://www.virginiadot.org/business/resources/LocDes/BMP_Design-Manual/BMP_Design_Manual_Cover.pdf*.

Virginia Department of Game and Inland Fisheries (VDGIF): **VDGIF** is responsible for the management of inland fisheries, wildlife, and recreational boating for the Commonwealth of Virginia. Part of the mission of VDGIF is to manage Virginia's wildlife and inland fish to maintain optimum populations of all species to serve the needs of the Commonwealth; to provide

opportunity for all to enjoy wildlife, inland fish, boating and related outdoor recreation; and to provide educational outreach programs and materials that foster an awareness of and appreciation for Virginia's fish and wildlife resources, their habitats, and hunting, fishing, and boating opportunities. More information and resources on VDGIF programs is available at *http://www.dgif.virginia.gov/*.

7.3 Local/Regional Government

Local government groups work closely with state and federal agencies throughout the TMDL process; these groups possess insights about their community that may help to ensure the success of TMDL implementation. Stakeholders have knowledge about a community's priorities, how decisions are made locally, and how the residents within a watershed interact. Some local government groups and their roles in the TMDL process are listed below.

Soil and Water Conservation Districts (SWCDs): SWCDs are local units of government responsible for the soil and water conservation work within their boundaries. The role of the districts is to increase voluntary conservation practices among farmers, ranchers and other land users. District staff work closely with watershed residents and have valuable knowledge of local watershed practices. The **Halifax** and **Pittsylvania SWCDs** participated in the IP development process through meeting attendance, comments and suggestions on agricultural practices included in the plan, and/or provision of watershed data.

Planning District Commissions (PDCs): PDCs were organized to promote the efficient development of the physical, social, and economic resources of the regional district, including the environment, by assisting and encouraging local governmental agencies to plan for the future. PDCs focus much of their efforts on water quality planning, which is complementary to the TMDL process. TMDL development and implementation projects are often contracted through PDCs. More information on the PDCs located in Virginia is available at *http://www.vapdc.org/*. The **West Piedmont Planning District Commission** (WPPDC) contracted the Birch Creek and Dan River TMDL IP project and participated in the IP development process through stakeholder contact information and outreach efforts, mapping/cartographic assistance, meeting coordination and attendance, comments and suggestions on various aspects of the plan.

County/City Government Departments: City and county government staff work closely with PDCs and state agencies to develop and implement TMDLs. They may also help to promote education and outreach to citizens, businesses, and developers to introduce the importance of the TMDL process. Local governments have the ability to enact ordinances that aid in the reduction of water pollutants and support BMP implementation such as requirements for pet waste pickup and septic system maintenance and pump out. They operate the local Virginia Stormwater Management Program in the capacity as a Virginia Stormwater Management Program Authority in accordance to the Stormwater Management Act (62.1-44.15:24). Representatives from **Halifax County**, and **Pittsylvania County**, and the **City of Danville** participated in the IP development process through meeting attendance, comments and suggestions on various aspects of the plan, and/or provision of watershed, BMP, and water quality data.

7.4 Community Groups and Citizens

While successful implementation depends on stakeholders taking responsibility for their role in the process, the primary role falls on the local groups that are most affected; that is, community watershed groups and citizens.

Community Watershed and Conservation Groups: Local watershed and conservation groups offer a meeting place and events for river and land conservation groups to share ideas and coordinate preservation efforts and are also a showcase site for citizen action. These groups also have a valuable knowledge of the local watershed and river habitat that is important to the implementation process. The following organization works in parts of the IP watershed.

Dan River Basin Association (*DRBA*) protects and promotes the Dan River basin through recreation, education and stewardship. The DRBA educates families, teachers, businesses, and the community as a whole by providing information on environmental awareness, health and sustainability, agricultural practices for conservation and resource protection, and appreciation of nature and natural resources. The DRBA further promotes stewardship through cleanup events, citizen water quality monitoring, riparian buffer demonstration sites, and projects focusing on stormwater and water quality improvement. The organization enhances regional recreational opportunities by hosting nature outings, providing information on regional outdoor recreational resources, and conducting master planning for and construction of trails, greenways, river access

points, blueways, wildlife habitat, and other environmentally friendly amenities. The DRBA works throughout the Dan River basin including the counties of Floyd, Franklin, Halifax, Henry, Mecklenburg, Patrick, and Pittsylvania in Virginia, and counties in North Carolina. Additional information is available at *http://www.danriver.org/*.

Citizens: The primary role of citizens within the TMDL and implementation process is involvement and input. This may include participating in public meetings, assisting with public outreach and education, providing input about the local watershed history, and/or implementing best management practices on their property to help restore water quality. Local residents and farmers have participated in the IP development process through meeting attendance, comments, and suggestions on various aspects of the plan.

Community Civic Groups: Community civic groups take on a wide range of community service including environmental projects. Such groups include Master Gardeners, farm clubs, homeowner associations and youth organizations, including Boy Scouts of America, 4-H, and Future Farmers of America. These groups offer a resource to assist in the public participation process, educational outreach, and assisting with implementation activities in local watersheds.

Southeast Rural Community Assistance Project, Inc. (SERCAP) is a nonprofit organization that focuses on improving the quality of life within rural communities including Virginia. Through training programs, technical assistance, and community action as well as partnerships with federal, state, regional and local agencies and businesses SERCAP primarily addresses water and wastewater needs in rural communities but also assists with community and economic development, housing, and health care.

Animal Clubs/Associations: Clubs and associations for various animal groups (e.g., beef, equine, poultry, swine, and canine) provide a resource to assist and promote conservation practices among farmers and other land owners, not only in rural areas, but in urban areas as well, where pet waste has been identified as a source of bacteria in waterbodies.

Virginia's approach to correcting nonpoint source pollution problems continues to be encouragement of participation through education and financial incentives; that is, outside of the

regulatory framework. If, however, voluntary approaches prove to be ineffective, it is likely that implementation will become less voluntary and more regulatory.

The benefits of involving the public in the implementation process can be very rewarding, but the process of doing so in an effective manner is often challenging. Therefore, it is the primary responsibility of these stakeholder groups to work with the various state agencies to encourage public participation and assure broad representation and objectivity throughout the IP development process.

8.0 Integration with Other Watershed Plans

Water quality in the Birch Creek and Dan River watersheds is an important component of the efforts of many different organizations, programs and activities. Such efforts include both voluntary and regulatory actions through watershed implementation plans, TMDLs, water quality management, stormwater management programs, source water assessment programs, local comprehensive and strategic plans, and local environmentally-focused organizations. These efforts should be evaluated to determine how they may compliment the implementation goals outlined in this plan and how local efforts can be more effective. Often these efforts are related or collaborative, but this is not always the case. Coordination of local programs can increase participation, prevent redundancy, and provide diversity. Initiatives coinciding with the Birch Creek and Dan River TMDL IP efforts include, but are not limited to, those described below.

8.1 Projects and Programs

There are various existing programs, projects, and plans that focus on aspects of the Birch Creek and Dan River watersheds including natural resources, water quality and quantity, stormwater, and public education. Brief descriptions of some of these are provided below.

8.1.1 Watershed-wide Programs

Virginia Scenic Rivers Program: Two separate segments of the Dan River were designated a Virginia Scenic River under the Virginia Scenic Rivers Act of 1970 (§10.1-400). The reach from Route 880 at Berry Hill Road downstream to Abreu-Grogan Park in Danville was designated in 2013, and the reach from the North Carolina-Virginia line downstream to the confluence with Aaron's Creek was designated in 2015. These designations encourage preservation and protection of the river and requires state agencies to consider visual, natural, and recreational values of a Scenic River in their planning and permitting processes.

Southern Virginia Wild Blueway: The Southern Virginia Wild Blueway is a water trail running within Halifax and Mecklenburg Counties. The Blueway includes portions of the Banister, Dan, and Staunton (Roanoke) Rivers for over 100 miles of navigable waters. River and lake access through the Blueway facilitates recreational pursuits such as canoeing, kayaking, fishing, and wildlife viewing.

8.1.2 Local Comprehensive and Other Plans

Each of the counties within the Birch Creek and Dan River watersheds has a comprehensive plan. Each of these plans provides goals and strategies for planning, development, land use, natural resources, and utilities that would help improve and protect the watershed and water quality and that would correspond with the goals of the Birch Creek and Dan River TMDL IP. Objectives highlighted include the protection and improvement of land, water, and other natural resources. Typical strategies to accomplish the plan objectives include the use of various agricultural, sewage disposal, and stormwater BMPs; sustainable use of resources; use of growth and development guidelines that complement and protect the environment; open space and farmland preservation; reduction of nonpoint source pollution; protection of natural functions of wetlands and floodplains; stormwater management; education on water pollution; and ordinances.

Other plans covering portions of the Birch Creek and Dan River watersheds and emphasizing topics and actions that support the IP include:

- *Rivers and Trails Master Plan, Patrick County, VA*, prepared by the Dan River Basin Association (DRBA 2013)
- *Implementation Plan Dan River Watershed Quality Improvement,* prepared by the Dan River Basin Association (DRBA 2016).

8.2 Other TMDL Implementation Plans

There is one other TMDL IP within the Dan River TMDL watershed. The Henry and Patrick Counties portion of the Dan River TMDL watershed was included in the *South Mayo River, North Mayo River, Blackberry Creek, Marrowbone Creek, Leatherwood Creek and Smith River Watershed Implementation Plan* (VADCR, 2013).

8.3 TMDL Action Plans

There are MS4 permits for the City of Danville, Danville Community College, and Virginia Department of Transportation (VDOT) within the Birch Creek and Dan River watersheds. MS4 permittees are required to limit and prevent, to the extent possible, pollutants from entering the stormwater system to protect the quality of surrounding surface waters. To achieve the required

TMDL wasteload allocations, MS4 operators must develop and implement a TMDL action plan that includes public education and outreach on stormwater impacts, public involvement and participation, illicit discharge detection and elimination, construction site stormwater runoff control, post-construction stormwater management in new development and redevelopment, and pollution prevention/good housekeeping for municipal operations. These include measures such as BMPs, stormwater management strategies, maintenance of stormwater infrastructure and discharge data, public involvement, education, and outreach. The MS4 permittees have an illicit discharge detection and elimination system in place. In preparing local TMDL action plans, MS4 permittees can use the IP as a resource for action plan development. However, the IP does not provide prescriptive actions for the localities to employ to meet their MS4 requirements.

8.4 Legal Authority

In accordance with the Virginia Stormwater Management Law and the Virginia Erosion, Sediment Control Law, ordinances regulating stormwater management and erosion and sediment control are required. The City of Danville is its own Virginia Stormwater Management Program Authority and conducts plan reviews and inspections, but the counties opted out and their review is handled through VADEQ. The regulations address land disturbing activities to prevent an increase in stormwater quality and quantity issues such as erosion, sedimentation, flooding, and polluted stormwater runoff and surface waters. Although every local program varies, each contains a stormwater pollution prevention plan (SWPPP) that must include a stormwater management plan, erosion and sediment control plan, and pollution prevention plan outlining techniques and BMPs to prevent and reduce stormwater related issues. Available BMPs are those described in the Virginia Stormwater BMP Clearinghouse; it is a source of the BMPs included in this IP as well. BMPs and other information in the Clearinghouse are available at *http://www.vwrrc.vt.edu/swc/*.

Ordinance creation is an avenue for compliance with proposed IP actions; however, the IP does not specifically prescribe ordinance creation. Localities have the option to pursue ordinances. The City of Danville has a pet waste ordinance that requires pet owners to pick up pet waste on public property and spaces. The city also has regulations concerning connection to the sewer system. Section 34-7 of the City code requires all houses within 300 feet of the public sanitary sewer to be connected to sewer with exceptions for properties with private wastewater disposal

systems, such as septic systems that are in good operating condition. Any private wastewater disposal system that malfunctions or fails and is within 300 feet of the sewer system must connect to the sewer.

8.5 Citizen Monitoring

VADEQ supports a program for the voluntary monitoring of state waters by citizen groups. This monitoring can assist in the listing or delisting of impaired waters, TMDL development through source identification, tracking progress of waters with approved TMDLs or TMDL implementation plans, and identifying waters for potential future VADEQ monitoring. Citizen monitoring also helps to educate the public about water quality in the region and the effect of anthropogenic land uses and activities on water quality. A quality assurance project plan is required before citizens can receive funding for water quality monitoring. State funding allows for development and support of monitoring programs, purchase of equipment, and educational materials. Additional information is available at *http://www.deq.state.va.us/Programs/Water/WaterQualityInformationTMDLs/WaterQualityMonitoring/CitizenMonitoring.aspx*.

In addition, DRBA also promotes the Citizen Water Quality Monitoring program. Please see http://www.danriver.org/programs/stewardship/citizen-monitoring and http://www.danriver.org/support-drba/take-action/water-monitoring.

9.0 Potential Funding Sources

This chapter describes funding sources potentially available for the implementation of the proposed control measures and practices developed in Chapter 5 of this IP. Funding options vary in applicability to specific watershed conditions, including pollutant sources and land uses, as well as the potential project sponsor(s). Programs and their requirements include, but are not limited to, those briefly described below.

9.1 Federal

EPA Federal Clean Water Act Section 319 Incremental Funds – Virginia is awarded grant funds through EPA, under Section 319 of the federal Clean Water Act, to implement TMDLs. Stakeholder organizations can apply, on a competitive basis through a Request for Proposals process directed by VADEQ, for 319 grants to implement BMPs and educational components included in an IP.

EPA Water Infrastructure Finance and Innovation Act (WIFIA) Funds – The WIFIA program was established by the Water Infrastructure Finance and Innovation Act of 2014. WIFIA provides long-term, low-cost supplemental loans for regionally and nationally significant projects. The funds can be used for development and implementation activities for eligible projects including, but not limited to, wastewater conveyance and treatment, drinking water treatment and distribution, enhanced energy efficiency projects at drinking water and wastewater facilities, acquisition of property if it is integral to the project or will mitigate the environmental impact of a project, and combinations of eligible projects. Loans can be combined with other funding sources including state Revolving Fund loans.

United States Department of Agriculture (USDA) – Farm Service Agency (FSA)

Conservation Reserve Program (CRP) – Cost-share assistance is available to establish tree or herbaceous vegetation cover on cropland through the CRP. Offers for the program are ranked, accepted, and processed during fixed signup periods that are announced by FSA. If accepted, contracts are developed for a minimum of 10 years and not more than 15 years. Land must have been owned or operated by the applicant for at least 12 months prior to the close of the signup period. The payment to the participant is up to 50% of the cost for establishing ground cover.

Incentive payments for wetlands hydrology restoration equal 25% of the cost of restoration. Information is available at *https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index.*

Conservation Reserve Enhancement Program (CREP) – This program is an enhancement of the existing USDA CRP Continuous Sign-up. The enhancements include an increase in the cost-share rates from 50% to 75% and 100%, an increase in the rental rates, and a flat rate incentive payment to place a permanent riparian easement on the enrolled area. Pasture and cropland (as defined by USDA) adjacent to streams, intermittent streams, seeps, springs, ponds and sinkholes are eligible to be enrolled. Buffers, consisting of native, warm-season grasses on cropland to mixed hardwood trees on pasture, must be established in widths ranging from the minimum of 30% of the floodplain or 35 feet, whichever is greater, to a maximum average of 300 feet. Cost-sharing (75% to 100%) is available to help pay for fencing to exclude livestock from the riparian buffer, watering facilities, hardwood tree planting, filter strip establishment, and wetland restoration. In addition, a 40% incentive payment upon completion is offered and an average rental rate of $70/acre on stream buffer area for 10 to 15 years. The Commonwealth of Virginia will make an additional incentive payment to place a perpetual conservation easement on the enrolled area. Program details are available at *https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-enhancement/index,* and *http://www.dcr.virginia.gov/soil_and_water/crep*.

USDA – Natural Resources Conservation Service (NRCS)

Conservation Stewardship Program (CSP) – The CSP is a voluntary program that encourages agricultural and forestry producers to address resource concerns by (1) undertaking additional conservation activities, and (2) improving and maintaining existing conservation systems. CSP provides financial and technical assistance to help land stewards conserve and enhance soil, water, air, and related natural resources on their land. CSP is available to all producers, regardless of operation size or crops produced. Eligible lands include cropland, grassland, prairie land, improved pastureland, rangeland, nonindustrial private forestland, and agricultural land

under the jurisdiction of an Indian tribe. For more information, visit *https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/*.

Environmental Quality Incentives Program (EQIP) – The 1996 Farm Bill established this program to provide a single voluntary conservation program for farmers and landowners to address significant natural resource needs and objectives. Approximately 65% of the EQIP funding for the state of Virginia is directed toward "Priority Areas." These areas are selected from proposals submitted by a locally led conservation work group. Proposals describe serious and critical environmental needs and concerns of an area or watershed and potential corrective actions to address these needs and concerns. The remaining 35% of the funds are directed toward statewide priority concerns of environmental needs. EQIP offers 5-year to 10-year contracts to landowners and farmers to provide 75% cost-share assistance, 25% tax credit, and/or incentive payments to implement conservation practices and address the priority concerns statewide or in the priority area. Additional information is available at *https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/*

Agricultural Lands Easement Program – The 2014 Farm Bill authorized funding for the new Agricultural Conservation Easement Program (ACEP), which consolidates the former Farm and Ranch Lands Protection Program, Grassland Reserve Program, and Wetlands Reserve Program into a single program. One component of the ACEP, the Agricultural Lands Easement Program, provides grants to purchase conservation easements that permanently restrict development on important farmland and reward landowners who participate in the program with permanent tax breaks. *https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/*

Regional Conservation Partnership Program (RCPP) – This program was authorized through the 2014 Farm Bill. This 5-year program promotes coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. NRCS provides assistance to producers through partnership agreements and through program contracts or easement agreements. The RCPP competitively awards funds to conservation projects designed by local partners specifically for their region. Eligible partners include agricultural or silvicultural producer associations, farmer cooperatives, state or local governments, municipal water treatment entities, conservation-driven nongovernmental organizations and institutions of higher

education. Under the RCPP, eligible landowners of agricultural land and non-industrial private forestland may enter into conservation program contracts or easement agreements under the framework of a partnership agreement. The Chesapeake Bay watershed is one of the eight "Critical Conservation Areas" identified for this program. More details are available at *https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/farmbill/rcpp/?cid=nrcseprd1308280*

Small Watershed Program (PL-566) – More recent program changes have allowed for acquisition of conservation easements within floodplains where repetitive damages have occurred, as well as the installation of land treatment measures similar to PL-534 on individual farms and other private land holdings to protect on-site productivity and improve water quality. Additional information is available at *http://www.nrcs.usda.gov/wps/portal/nrcs/main/va/programs/planning/wpfp/*.

USFWS – United States Fish and Wildlife Service

United States Fish and Wildlife Service (USFWS) – The Fish and Wildlife Service administers a variety of natural resource assistance grants to governmental, public and private organizations, groups and individuals. Natural resource assistance grants are available to state agencies, local governments, conservation organizations, and private individuals.

9.2 State

Virginia Agricultural Best Management Practices Cost-Share Program – The cost-share program is funded with state and federal monies through local soil and water conservation districts, which administer the local programs with state oversight through VADCR. The program encourages farmers and landowners to use BMPs on their land to better control transport of pollutants into waters due to excessive surface flow, erosion, leaching, and inadequate animal waste management. Program participants are recruited by SWCDs based on those factors, which have a significant impact on water quality. Cost-share is typically 75% of the actual cost. Details concerning this program are available at *http://www.dcr.virginia.gov/soil_and_water/costshar.shtml#tools*, and *http://dswcapps.dcr.virginia.gov/htdocs/agbmpman/csmanual.pdf*.

Virginia Agricultural Best Management Practices Tax Credit Program – For all taxable years, any individual or corporation engaged in agricultural production for market, who has a soil conservation plan approved by the local SWCD in place, is allowed a credit against the tax imposed by Section 58.1-320. The amount of the tax credit would equal 25% of the first $70,000 expended for agricultural BMPs by the individual. Additionally, the amount of the credit cannot exceed $17,500 or the total amount of the tax imposed by this program (whichever is less) in the year the project was completed. If the amount of the credit exceeds the taxpayer's liability for such taxable year, the excess may be carried over for credit against income taxes in the next five taxable years until the total amount of the tax credit has been taken. Any BMP approved by the local SWCD Board must be completed within the taxable year in which the credit is claimed. The credit is only allowed for expenditures made by the taxpayer from funds of his/her own sources. It is also approved for use in supplementing the cost of repairs to streamside fencing (state BMP practice, WP-4D). Details concerning eligible BMPs and other program details are available at

http://www.dcr.virginia.gov/soil_and_water/costshar.shtml#tools, and

http://dswcapps.dcr.virginia.gov/htdocs/agbmpman/csmanual.pdf.

Virginia Clean Water Revolving Loan Fund – The EPA awards grants to states to capitalize their Clean Water State Revolving Funds (CWSRFs). The states, through the CWSRF, make loans for high-priority water quality activities. As loan recipients make payments back into the fund, money is available for new loans to be issued to other recipients. Eligible projects include point source, nonpoint source and estuary protection projects. Point source projects typically include building wastewater treatment facilities, combined sewer overflow and sanitary sewer overflow corrections, urban stormwater control, and water quality aspects of landfill projects. Nonpoint source projects include agricultural, silvicultural, rural, and some urban runoff control; on-site wastewater disposal systems (septic tanks); land conservation and riparian buffers; and leaking underground storage tank remediation. Additional information is available at *http://water.epa.gov/grants_funding/cwsrf/cwsrf_index.cfm*.

Virginia Department of Environmental Quality Citizen Water Monitoring Grant Program – The primary purpose of this program is to provide funding for groups and individuals to monitor the quality of Virginia's waters. The grant can be used in a variety of ways, including purchasing water quality monitoring equipment, training citizen volunteers, lab analysis costs, and promoting stream monitoring efforts in locations where VADEQ is not currently collecting water quality samples. To be eligible for funding under the regular Citizen Monitoring Grant, a grantee must follow certain guidelines, including developing a quality assurance project plan (QAPP).

Virginia Department of Forestry

Urban and Community Forestry Assistance Program (U&CF) – Funds for the U&CF Program are provided by the USDA Forest Service and are administered by the Virginia Department of Forestry. The U&CF Program is designed to encourage projects that promote tree planting, the care of trees, the protection and enhancement of urban and community forest ecosystems, and education on tree issues in cities, towns, and communities across the nation. Grants may be awarded to state agencies, local and regional units of government, approved non-profit organizations, neighborhood associations, civic groups, public educational institutions (college level) or community tree volunteer groups for proposals, which meet some, or all, of the specific program objectives. Non-governmental organizations must be designated a 501-c-3 non-

profit organization or submit their application through such an organization or a government entity. The typical proposal is in the $5,000 to $10,000 range.

Virginia Forest Stewardship Program – The purpose of this program is to encourage the long-term stewardship of nonindustrial private forestlands, by assisting the owners of such lands to more actively manage their forest and related resources. The Forest Stewardship Program provides assistance to owners of forestland and other lands where good stewardship, including agroforestry applications, will enhance and sustain the long-term productivity of multiple forest resources. Special attention is given to landowners in important forest resource areas and those new to, or in the early stages of, managing their land in a way that embodies multi-resource stewardship principles. The program provides landowners with the professional planning and technical assistance they need to keep their land in productive and healthy conditions.

Private nonindustrial forestlands that are managed under existing federal, state, or private sector financial and technical assistance programs are eligible for assistance under the Forest Stewardship Program. Forest resource management activities on such forestlands must meet, or be expanded or enhanced to meet, the requirements of the Forest Stewardship Program. Participation in the Forest Stewardship Program is voluntary. To enter the program, landowners agree to manage their property according to an approved Forest Stewardship Management Plan. Landowners also understand that they may be asked to participate in future management outcome monitoring activities. Additional information is available at *http://www.dof.virginia.gov/manage/stewardship/index.htm*, and *https://www.fs.fed.us/managing-land/forest-stewardship/program*.

Virginia Outdoors Foundation (VOF) – VOF was created by the General Assembly in 1966 to promote the preservation of open-space lands and to encourage private gifts of money, securities, land or other property to preserve the natural, scenic, historic, scientific, open-space and recreational areas of the Commonwealth. The primary way VOF protects land is by holding conservation easements, which are voluntary agreements with landowners that restrict certain types of development on land in perpetuity. VOF also accepts donations of land, which it either protects with an easement and transfers to another landowner, or owns and manages for public benefit.

VOF also administers the Open Space Lands Preservation Trust Fund, which assists landowners with the costs of conveying open-space easements and purchases all or part of the value of easements. Priority for funding is given to applications on family farms and for those with demonstrated financial need. For more information, visit the Preservation Trust Fund page. A gift of a permanent open-space easement may qualify as a charitable gift and be eligible for certain state and federal tax benefits. In addition, there may be local property tax reductions and federal estate tax exemptions. An independent certified appraiser must establish the value of the easement that is primarily based on the value of the development rights forgone. Once that value is established, it becomes the basis for calculating tax benefits. Additional information is available at *http://www.virginiaoutdoorsfoundation.org/*.

Virginia Small Business Environmental Compliance Assistance Loan Fund – The Fund, administered through VADEQ, is used to make loans or to guarantee loans to small businesses for the purchase and installation of environmental pollution control equipment, equipment to implement voluntary pollution prevention measures, or equipment and structures to implement agricultural BMPs. The equipment shall allow the small business to (1) comply with the federal Clean Air Act or to (2) implement voluntary pollution prevention measures. The loans are available in amounts up to $100,000 and will carry an interest rate of 3%, with favorable repayment terms based on the borrower's ability to repay and the useful life of the equipment being purchased or the life of the BMP being implemented. To be eligible for assistance, a business must employ 100 or fewer people and be classified as a small business under the federal Small Business Act. Further information is available at *http://www.deq.virginia.gov/portals/0/deq/air/smallbusinessassistance/autobody/appendix13.pdf*.

Virginia Stormwater Local Assistance Fund (SLAF) – SLAF funds stormwater projects including: (1) new stormwater best management practices, (2) stormwater BMP retrofits, (3) stream restoration, (4) low impact development projects, (5) buffer restorations, (6) pond retrofits, and (7) wetland restoration. Eligible recipients are local governments, meaning any county, city, town, municipal corporation, authority, district, commission, or political subdivision created by the General Assembly or pursuant to the Constitution or laws of the Commonwealth. The fund is administered by VADEQ.

Virginia Water Quality Improvement Fund (WQIF) – This is a permanent, non-reverting fund established by the Commonwealth of Virginia to assist local stakeholders in reducing point and nonpoint nutrient loads to surface waters. Eligible recipients include local governments, SWCDs, and individuals. Grants for point sources and nonpoint sources are administered through VADEQ. Most WQIF grants provide matching funds on a 50/50 cost-share basis. Additional information is available at *http://www.deq.virginia.gov/Programs/Water/CleanWaterFinancingAssistance/WaterQualityImprovementFund.aspx*.

9.3 Regional and Private

Community Development Block Grant (CDBG) – The CDBG program is a flexible program that provides communities with resources to address a wide range of unique community development needs. Beginning in 1974, the CDBG program is one of the longest continuously run programs at the U.S. Department of Housing and Urban Development. The CDBG program provides annual grants on a formula basis to 1209 general units of local government and states. This program is administered by the Department of Housing and Community Development (DHCD). Additional information is available at *http://www.dhcd.virginia.gov/index.php/business-va-assistance/blighted-structures/community-development-block-grant-cdbg/10-community-development-block-grant-cdbg.html*.

Over a 1-, 2-, or 3-year period, as selected by the grantee, not less than 70% of CDBG funds must be used for activities that benefit low- and moderate-income persons. In addition, each activity must meet one of the following national objectives for the program: benefit low- and moderate-income persons, prevention or elimination of slums or blight, or address community development needs having a particular urgency because existing conditions pose a serious and immediate threat to the health or welfare of the community for which other funding is not available. Information on the program, participation, and eligible activities is available at *https://www.hud.gov/program_offices/comm_planning/communitydevelopment/programs*.

National Fish and Wildlife Foundation (NFWF) – Proposals for grants are accepted throughout the year and processed during fixed sign-up periods. There are two decision cycles per year. Each cycle consists of a pre-proposal evaluation, a full proposal evaluation, and a

Board of Directors' decision. Grants generally range between $10,000 and $150,000. Grants are awarded for the purpose of conserving fish, wildlife, plants, and their habitats. Special grant programs are listed and described on the NFWF website *(http://www.nfwf.org)*. If the project does not fall into the criteria of any special grant programs, a proposal may be submitted as a general grant if it falls under the following guidelines: (1) it promotes fish, wildlife and habitat conservation, (2) it involves other conservation and community interests, (3) it leverages available funding, and (4) project outcomes are evaluated.

Five Star and Urban Waters Restoration Grant Program – This NFWF program seeks to develop nationwide community stewardship of local natural resources, preserving these resources for future generations and enhancing habitat for local wildlife. Projects seek to address water quality issues in priority watersheds, such as erosion due to unstable streambanks, pollution from stormwater runoff, and degraded shorelines caused by development. The program requires the establishment and/or enhancement of diverse partnerships and an education/outreach component that will help shape and sustain behavior to achieve conservation goals. The Five Star program provides $20,000 to $50,000 grants with an average award size of $25,000. Grants that are in the $30,000 to $50,000 range are typically for two years and are for urban areas. Additional information for this program is available at *http://www.nfwf.org/fivestar/Pages/home.aspx*.

Funding priorities for this program include:

- On-the-ground wetland, riparian, in-stream and/or coastal habitat restoration
- Meaningful education and training activities, either through community outreach, participation and/or integration with K-12 environmental curriculum
- Measurable ecological, educational and community benefits
- Partnerships: Five Star projects should engage a diverse group of community partners to achieve ecological and educational outcomes.

RiverBank Fund – The fund is administered by the Community Foundation of the Dan River Region to protect and revitalize the Dan River in the Virginia counties of Halifax, Henry, Mecklenburg, Patrick, and Pittsylvania and in North Carolina. The purpose of the fund is to responsibly address water quality for regional residents and companies; encourage new development that ecologically features the River; improve the cleanliness of the river and its

basin and help protect it from environmental threats; increase access to the river for family-friendly sports, recreation and entertainment; and effectively promote the river to build regional pride and encourage tourism. Details are available at *http://www.cfdrr.org/grants/riverbank-fund/*.

Southeast Rural Community Assistance Project (SERCAP) – The mission of this project is to promote, cultivate, and encourage the development of water and wastewater facilities to serve low-income residents at affordable costs and to support other development activities that will improve the quality of life in rural areas. Staff members of other community organizations complement the SERCAP staff across the region. They can provide, at no cost: on-site technical assistance and consultation, operation and maintenance/management assistance, training, education, facilitation, volunteers, and financial assistance. Financial assistance includes $1,500 toward repair, replacement, or installation of a septic system, and $2,000 toward repair, replacement, or installation of an alternative waste treatment system. Funding is only available for families making less than 125% of the federal poverty level. Details about specific loans and funding opportunities are available at *http://www.sercap.org/*.

Virginia Environmental Endowment – The Virginia Environmental Endowment is a nonprofit, independent grant-making foundation whose mission is to improve the quality of the environment by using its capital to encourage all sectors to work together to prevent pollution, conserve natural resources, and promote environmental literacy. Current grant-making priorities in Virginia include improving local rivers and protecting water quality throughout Virginia, restoring Chesapeake Bay, enhancing land conservation and sustainable land use, advancing environmental literacy and public awareness, and supporting emerging issues in environmental protection. Applications are accepted biannually with deadlines of June 15 and December 1. Guidelines and application information are available at *http://www.vee.org/*.

Wetland and Stream Mitigation Banking – Mitigation banks are sites where aquatic resources such as wetlands, streams and streamside buffers are restored, created, enhanced, or in exceptional circumstances, preserved expressly for the purpose of providing compensatory mitigation in advance of authorized impacts to similar resources. Mitigation banking is a commercial venture that provides compensation for aquatic resources in financially and

environmentally preferable ways. Not every site or property is suitable for mitigation banking. Mitigation banks are required to be protected in perpetuity, to provide financial assurances and long-term stewardship. The mitigation banking process is overseen by an Inter-Agency Review Team made up of state and federal agencies and chaired by VADEQ and the U.S. Army Corps of Engineers.

Virginia Tobacco Region Revitalization Commission Grant Programs- The mission of the commission is the promotion of economic growth and development in tobacco-dependent communities, using proceeds of the national tobacco settlement. They operates several programs that provide grant or loan funds to accomplish specific economic revitalization objectives. All programs require dollar-for-dollar matching funds. Additional information is available at *https://www.revitalizeva.org/grant-loan-program/grant-programs/*

Duke Energy Water Resources Fund. The Duke Energy Foundation has a fund for projects benefiting waterways in the Carolinas or immediately downstream of their operational facilities in Virginia, Tennessee and Georgia. There is a $1.5 million designation for projects in the Dan River Basin Region that benefit waterways or help develop the economic and community vitality of the region. Nonprofit organizations or local governmental organizations that can apply for funding for science-based and research-supported programs that provide direct benefit to at least one of the following focus areas:

- Improve water quality, quantity and conservation
- Enhance fish and wildlife management habitats
- Expand public use and access to waterways
- Increase citizens' awareness about their roles in protecting water resources

Additional information can be found at *https://www.duke-energy.com/community/duke-energy-foundation/water-resources-fund and https://www.duke-energy.com/_/media/pdfs/community/wrf-territory.pdf?la=en*

10.0 References

Bockstael, N.E., A.M. Freeman III, R.J. Kopp, P.R. Portney, and V.K. Smith. 2000. On measuring economic values for nature. Environmental Science & Technology 34: 1384-1389.

CDC (Centers for Disease Control). 2001. Outbreaks of *Escherichia coli* 0157:H7 infections among children associated with farm visits --- Pennsylvania and Washington, 2000. CDC Morbid Mortality Weekly Report 50(15): 293-297. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5015a5.htm.

Doggie Dooley. 2018. Doogie Dooley Website. Available at: *http://www.doggiedooley.com/model--3000.html*.

DRBA (Dan River Basin Association). 2013. *Rivers and Trails Master Plan, Patrick County, VA*. Available at: *http://www.danriver.org/content/danriver/uploads/PDF/our_watershed/rivers_trails_master_plan_final.pdf*.

DRBA (Dan River Basin Association). 2016. *Implementation Plan Dan River Watershed Quality Improvement*. Available at: *http://www.danriver.org/content/danriver/uploads/waterqualityplan.pdf*.

EPA (U.S. Environmental Protection Agency). 1999. Guidance for Water Quality-Based Decisions: The TMDL Process. Available at: *http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/decisions_index.cfm*.

Evans, B.M., S.A. Sheeder, and D.W. Lehning. 2003. A spatial technique for estimating streambank erosion based on watershed characteristics. Journal of Spatial Hydrology 3(1).

Heintz, J., R. Pollin, and H. Garrett-Peltier. 2009. How infrastructure investments support the U.S. economy: employment, productivity and growth. Political Economy Research Institute, Amherst, MA. Available at: *http://americanmanufacturing.org/files/peri_aam_finaljan16_new.pdf.*

Hunt, W.F., J.T. Smith, and J. Hathaway. 2007. City of Charlotte Pilot BMP Monitoring Program, Mal Marshall Bioretention Final Monitoring Report. Prepared for the City of Charlotte.

Johnston, D.M., J.B. Braden, and T.H. Price. 2006. Downstream economic benefits of conservation development. Journal of Water Resources Planning and Management. Vol 132(1): 35-43.

Jones, G.M., and T.L. Balley, Jr. 2009. Understanding the basics of mastitis. Virginia Cooperative Extension 404-233.

Landefeld, M., and J. Bettinger. 2002. Water effects on livestock performance. Ohio State University Agriculture and Natural Resources Report ANR-13-02, Columbus, Ohio. Available at: *http://ohioline.osu.edu/anr-fact/pdf/0013.pdf*.

Medina, D.E., J. Monfils, and Z. Baccata. 2011. Green infrastructure benefits for floodplain management: a case study. Stormwater: The Journal for Surface Water Quality Professionals.

Rivanna River Basin Commission. 2012. Moores Creek Bacteria Implementation Plan 2012 Update.

Schueler, T., D. Hirschmann, M. Novotney, and J. Zielinski. 2007. Urban Stormwater Retrofit Practices Version 1.0. Urban Watershed Restoration Manual No. 3, Center for Watershed Protection. Prepared for U.S. Environmental Protection Agency.

Surber, G., K. Williams, and M. Manoukian. 2005. Drinking water quality for beef cattle: an environmentally friendly and production management enhancement technique. Animal and Range Sciences, Extension Service, Montana State University. Available online at: *www.animalrangeextension.montana.edu/articles/NatResourc/Drinking%20Water%20Quality%20for%20Beef%20Cattle.pdf.*

Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD. 112p.

USEPA (U.S. Environmental Protection Agency). 2014a. Best Management Practices: Bioretention. Available at: *http://water.epa.gov/polwaste/npdes/swbmp/Bioretention-Rain-Gardens.cfm*, accessed January 20, 2014.

USEPA (U.S. Environmental Protection Agency). 2014b. Best Management Practices: Infiltration Trench. Available at: *http://water.epa.gov/polwaste/npdes/swbmp/Infiltration-Trench.cfm*, accessed January 20, 2014.

USEPA-CBP (U.S. Environmental Protection Agency-Chesapeake Bay Program). 2006. Nonpoint Source Best Management Practices that have been Peer-Reviewed and CBP-approved for Phase 5.0 of the Chesapeake Bay Program Watershed Model, Revised 02/09/2011.

VADCR (Virginia Department of Conservation and Recreation). 2003. Virginia Guidance Manual for Total Maximum Daily Load Implementation Plans. Available at: http://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/ImplementationPlans/ipguide.pdf.

VADCR (Virginia Department of Conservation and Recreation). 2006. Water Quality Implementation Plan for Blacks Run and Cooks Creek (Fecal Coliform and Aquatic Life TMDLs).

VADCR (Virginia Department of Conservation and Recreation). 2013. Spout Run Water Quality Improvement Plan.

VADCR (Virginia Department of Conservation and Recreation). 2013. South Mayo River, North Mayo River, Blackberry Creek, Marrowbone Creek, Leatherwood Creek and Smith River Watershed Implementation Plan. May 2013. Available at: *http://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/ImplementationPlans/Smith-Mayo_Technical_Report_FINAL.pdf*

VADCR (Virginia Department of Conservation and Recreation). 2013. Virginia Agricultural BMP and CREP Database. Average of reported cost for Upper Roanoke River Watershed BMPs. Available at: *http://dswcapps.dcr.virginia.gov/htdocs/progs/BMP_query.aspx*.

VADEQ (Virginia Department of Environmental Quality). 2004. Bacteria TMDL for Birch Creek Watershed, Virginia. June 2004. Available at: *http://www.deq.virginia.gov/portals/0/DEQ/Water/TMDL/apptmdls/roankrvr/birchfc.pdf*

VADEQ (Virginia Department of Environmental Quality). 2006a. Bacteria TMDLs for Wilson Creek, Ore Branch, and Roanoke River Watersheds, Virginia. February 2006. Available at: *http://www.deq.virginia.gov/portals/0/DEQ/Water/TMDL/apptmdls/roankrvr/uroanec.pdf*

VADEQ (Virginia Department of Environmental Quality). 2008. Bacteria TMDL Development for the Dan River, Blackberry Creek, Byrds Branch, Double Creek, Fall Creek, Leatherwood Creek, Marrowbone Creek, North Fork Mayo River, South Fork Mayo River, Smith River, Sandy Creek, and Sandy River Watersheds. September 2008. Available at: *http://www.deq.virginia.gov/portals/0/DEQ/Water/TMDL/apptmdls/roankrvr/danec.pdf*

VADEQ (Virginia Department of Environmental Quality). 2011. Bacterial Implementation Plan Development for the James River and Tributaries – City of Richmond Technical Report.

VADEQ (Virginia Department of Environmental Quality). 2012. Lower Banister River Watershed Implementation Plan.

VADEQ (Virginia Department of Environmental Quality). 2012. South Mayo River, North Fork Mayo River, South Fork Mayo River, Blackberry Creek, Marrowbone Creek, Leatherwood Creek, and Smith River Watershed Implementation Plan.

VADEQ (Virginia Department of Environmental Quality). 2013. Three Creek, Mill Swamp, and Darden Mill Run Watersheds TMDL Implementation Plan Technical Report.

VADEQ (Virginia Department of Environmental Quality). 2013. Virginia Stormwater Management Handbook. Available at: *http://www.deq.virginia.gov/fileshare/wps/2013_SWM_Handbook/*.

VADEQ (Virginia Department of Environmental Quality). 2014a. Final 2014 305(b)/303(d) Water Quality Assessment Integrated Report. Available at:

http://www.deq.virginia.gov/Programs/Water/WaterQualityInformationTMDLs/WaterQualityAssessments/2014305(b)303(d)IntegratedReport.aspx.

VADEQ (Virginia Department of Environmental Quality). 2014b. Water Quality Assessment Guidance Manual for 2014 305(b)/303(d) Integrated Water Quality Report. Available at: *http://www.deq.virginia.gov/Portals/0/DEQ/Water/Guidance/142005.pdf*.

VADEQ (Virginia Department of Environmental Quality). 2016. Roanoke River Bacteria and Sediment TMDL Implementation Plan. Available at: *http://www.deq.virginia.gov/Portals/0/DEQ/Water/TMDL/ImplementationPlans/Roanoke_River_TMDL_IP_Part%20II.pdf*.

VCE (Virginia Cooperative Extension). 1996. Controlled grazing of Virginia's pastures, by Harlan E. White and Dale D. Wolf, Virginia Cooperative Extension Agronomists; Department of Forages, Crop, and Soil Environmental Sciences, Virginia Tech. Publication Number 418-012. July 1996. Available at: *http://pubs.ext.vt.edu/418/418-012/418-012.html*.

Wise, S. 2007. Bringing benefits together: capturing the value(s) of raindrops where they fall. Center for Neighborhood Technology. Presented at the U.S. EPA Wet Weather and CSO Technology Workshop, Florence, KY, September 2007.

Zeckoski, R., B. Benham, and C. Lunsford. 2007. Streamside Livestock Exclusion: A tool for increasing farm income and improving water quality. Virginia Cooperative Extension Publication No. 442-766. Available at: *www.ext.vt.edu/pubs/bse/442- 766/442-766.html*.

Appendix A – Impaired Waters Tables

Table A-1: Bacteria Impairment Summary

Assessment Unit	Stream Name	Length (mi)	Boundaries	Listing Station ID	Impair-ment	TMDL Established or Nested
VAC-L62R_BTC01A08	Big Toby Creek	7.57	Big Toby Creek from its headwaters to its mouth on the Dan River	4ABTC000.60	*Escherichia coli*	Nested
VAC-L63R_BIR01A98	Birch Creek	20.14	From its headwaters to its mouth on the Dan River	4ABIR001.00	*Escherichia coli*	Established
VAC-L63R_XDK01A06	Birch Creek, Unnamed Tributary	5.35	From its headwaters to the mouth on Birch Creek	4AXDK000.94	*Escherichia coli*	Nested
VAC-L62R_BYR01A04	Byrds Branch	3.76	Byrds Branch from its headwaters to the mouth at the Dan River	4ABYR002.13, 4ABYR000.08	*Escherichia coli*	Established
VAC-L60R_CAN1A02	Cane Creek	12.26	Cane Creek mainstem from its headwaters downstream to the VA/NC State Line.	4ACAN000.80	*Escherichia coli*	Nested
VAC-L57R_CAS01A00	Cascade Creek	11.79	Cascade Creek mainstem from the VA/NC State Line upstream to its headwaters.	4ACAS001.92	*Escherichia coli*	Nested
VAC-L62R_DAN02A98	Dan River	11.86	Mineral Springs Branch to Route 658 bridge.	4ADAN028.90	*Escherichia coli*	Established
VAC-L62R_DAN03A98	Dan River	2.81	Route 658 bridge to Birch Creek.	4ADAN028.90	*Escherichia coli*	Established
VAC-L64R_DAN04A98	Dan River	10.53	Birch Creek to South Boston raw water intake location.	4ADAN015.30	*Escherichia coli*	Established
VAC-L64R_DAN05A98	Dan River	6.58	South Boston raw water intake location to Banister River.	4ADAN015.30	*Escherichia coli*	Established
VAC-L73R_DAN06A98	Dan River	3.3	Dan River from the Banister River (watershed boundary) to the Peter Creek confluence (Kerr Reservoir)		*Escherichia coli*	Established
VAW-L42R_DAN02A02	Dan River	5.81	Dan River mainstem from the Squirrel Creek mouth upstream to the Pinnacles Power House Class V (RD02).	4ADAN181.10	*Escherichia coli*	Established
VAW-L42R_DAN01A00	Dan River	9.67	Dan River mainstem from the VA/NC State Line upstream to the Squirrel Creek mouth on the Dan River Class V (RD02).		*Escherichia coli*	Established
VAC-L62R_DBC01A98	Double Creek	8.89	Headwaters to Dan River	4ADBC002.19	*Escherichia coli*	Established
VAC-L61R_FAL01A00	Fall Creek	11.97	Fall Creek mainstem from its mouth on the Dan River upstream to its headwaters.	4AFAL001.58	*Escherichia coli*	Established
VAC-L63R_GER01A08	Germy Creek	5.37	Germy Creek from its headwaters to its mouth on Birch Creek	4AGER001.17	*Escherichia coli*	Nested
VAC-L61R_LAW01A04	Lawless Creek	4.72	Lawless Creek from its headwaters to its mouth at Fall Creek.	4ALAW002.43	*Escherichia coli*	Nested
VAC-L64R_LSN01A98	Lawsons Creek	8.27	Headwaters to Jerimy Creek	4ALSN007.45	*Escherichia coli*	Nested
VAC-L64R_LSN02A02	Lawsons Creek	7.27	Jerimy Creek to Dan River	4ALSN007.45	*Escherichia coli*	Nested
VAC-L64R_MRY01A04	Miry Creek	1.12	Miry Creek from the Mikes Creek confluence to the Dan River	4AMRY000.82	*Escherichia coli*	Nested
VAC-L62R_POW01A08	Powells Creek	4.63	Powells Creek from its headwaters to its mouth on the Dan River	4APOW000.69	*Escherichia coli*	Nested

Table A-1: Bacteria Impairment Summary

Assessment Unit	Stream Name	Length (mi)	Boundaries	Listing Station ID	Impair-ment	TMDL Established or Nested
VAC-L60R_PKP01A06	Pumpkin Creek	4.28	From the VA/NC line to the mouth on the Dan River	4APKP002.31	*Escherichia coli*	Nested
VAC-L62R_SLC01A04	Sandy Creek	9.41	Sandy Creek from its headwaters to the mouth at the Dan River	4ASLC002.75	*Escherichia coli*	Nested
VAC-L59R_SCR02A02	Sandy Creek	9.49	Sandy Creek mainstem from near its headwaters downstream to the confluence of Little Sandy Creek.	4ASCR007.06	*Escherichia coli*	Established
VAC-L58R_SRV01A00	Sandy River	7.23	Sandy River mainstem from the Hickory Forest Creek mouth downstream to the Sandy River confluence on the Dan River.	4ASRV000.20	*Escherichia coli*	Established
VAC-L58R_SRV04A06	Sandy River	10.79	From its headwaters to its confluence with Bawley Branch	4ASRV025.40, 4ASRV022.99	*Escherichia coli*	Nested
VAC-L58R_SWA01A08	Stewart Creek	7.34	Stewart Creek from its headwaters to its mouth on Sandy River	4ASWA002.97	*Escherichia coli*	Nested
VAC-L64R_SKS01A08	Stokes Creek	6.36	Stokes Creek from its headwaters to its mouth on Lawsons Creek	4ASKS002.80	*Escherichia coli*	Nested
VAC-L58R_SUT01A08	Sugartree Creek	6.97	Sugartree Creek from its headwaters to its mouth on Sandy River	4ASUT000.89	*Escherichia coli*	Nested
VAC-L58R_TRD01A06	Tanyard Creek	2.86	From the confluence of Glady Fork to South Prong Sandy River	4ATRD000.04	*Escherichia coli*	Nested

Source: Based on Virginia's Final 2014 305(b)/303(d) Water Quality Assessment Integrated Report

Appendix B – Meeting Minutes and Summaries

Table B-1: Meetings During Development of the Birch Creek and Dan River TMDL Implementation Plan

Date	Meeting Type	Notes?
08/29/2017	Public Meeting #1	Y
10/03/2017	Government Working Group #1	Y
10/03/2017	Agricultural Working Group #1	Y
10/03/2017	Residential Working Group #1	Y
03/13/2018	Agricultural Working Group #2 and Residential Working Group #2	Y
05/24/2018	Steering Committee Meeting #1	Y
06/05/2018	Public Meeting #2	N

Birch Creek and Dan River Watersheds TMDL Implementation Plan

First Public Meeting

August 29, 2017, 6:00 p.m. - 8:00 p.m.
Danville Regional Airport Eastern Conference Room, Danville, VA

Meeting Attendees: Paula Main, Lucy Baker, Ashley Wendt (Virginia Department of Environmental Quality); Susan Lindstrom (Louis Berger); Rick Brown, Bruce Pearce (Halifax SWCD); David Hoback, Leah Manning (West Piedmont PDC); Bill McCaleb (Virginia Cooperative Extension Halifax); Aubrey Clark (Halifax County Service Authority); Alan Johnson (City of Danville); Barbara Hulson, Deborah Dir (PRIDE); Charles Oureby, Robert Clifton (Severn Trent Services); Lloyd Clark; Eli Adkins; Earl Adkins; Bill Guerrant; Cherie Guerrant; Ralph Alderson

Introduction - Paula Main

- Introduction of participants - name and affiliation
    - Need volunteers to be a part of the different working groups— residential, agricultural, and government
    - Throughout the presentation think about your willingness to participate. We will fill out cards near the end

Presentation - Louis Berger

- Goal is to develop a plan to clean-up the stream
- The presentation addressed the overall project plan and process, reviewed the TMDL, Public participation overview and implementation plan development timeline
- Review TMDL
    - TMDL has been completed but this meeting represents the beginning of the Implementation Plan
    - Explanation of the Total Maximum Daily Load (TMDL)
    - Relevant water quality standards—E. coli standard is geometric mean 126 cfu/100 mL and 235 cfu/100 mL instantaneous standard
    - Two relevant TMDL reports: Birch Creek bacteria TMDL in 2004 and Dan River bacteria TMDL in 2008
    - TMDL is what we need to do and IP is how.
    - IP guidance manual will be used to formulate IP
    - Goals = reduce pollutants, restore waterbodies to attain use standard, and delist from 303(d) list
    - Requirements: data of expected achievement, measurable goals, corrective actions, associated costs, benefits and environmental impact
- Watershed overview - TMDL describes sources but modifications will be made to WLA and LA
    - Updates will be made to land us/cover
    - Overview of sources - humans, livestock, wildlife, and pets

- Public participation - Two public meetings and working group meetings, steering committee meeting during draft stage
    - Responsibilities = review implementation constraints,
    - Next steps = working groups - Agricultural, Residential, and Governmental
        - Agricultural = implementation strategies from agricultural perspective
        - Residential = evaluate corrective actions, outreach from homeowner's perspective
        - Government = identify regulatory controls in place, measure goals and timeline for achievement
        - Steering committee = meet one time during plan, review results, address community concerns/suggestions
- 1st working group meetings in Oct. 2017; 2nd meeting Feb. 2018; Final report/ public meeting in May

Questions

- What does sewage sludge refer to?
    - Considered industrial waste
- How recent is the data?
    - These sites were sampled recently and still listed on the 303(d) list
- Are the sources weighted equally or ranked?
    - Yes, land use is factored in and how much E. coli per animal is taken into account in the modeling.
- What are the residential processes referring to?
    - Failing septic systems
- What is the success rate for these IPs?
    - Compared to many states VA has been very successful in delisting waters
- What are the harms of high levels of E. coli- human health concern but also a concern with groundwater and irrigation practices?
    - Major concern is for human health and that's how the standards were designed but E. coli can effect groundwater and crops irrigated with high E. coli concentration water.
- Concern about locating exactly where biosolids are spread and can't find information from DEQ
    - Locations were biosolids are applied are in the applicators permit but must be accessed via a FOIA request.

Contact James Moneymaker if you are interested in being on a working group or have any questions:
James.moneymaker@deq.virginia.gov
(540)562-6738

Meeting Adjourn

Birch Creek and Dan River Watersheds TMDL Cleanup Plan

Government Working Group

October 3, 2017
Danville Regional Airport, Eastern Conference Room

Meeting Attendees: James Moneymaker, Paula Main, Lucy Baker (Virginia Department of Environmental Quality); Susan Lindstrom, Ginny Snead (Louis Berger); Aubrey Clark (Halifax County Service Authority); Hanna Lindsey, Amber Eanes (Pittsylvania SWCD); Robert Clifton (Severn Trent Services, Danville WWTP operator); David Hoback, Leah Manning (West Piedmont PDC); Bryce Simmons, Alan Johnson (City of Danville); Brian Williams (Dan River Basin Association)

Information Request:

DEQ would appreciate localities sending the information listed below. While we are seeking detailed information, any form or level of information would be appreciated.

- Stormwater BMP (GIS Layers)
    - Type of BMP (Detention (Dry) Basin, Retention (Wet) Basin, Bioretention, Infiltration Trench, Manufactured Units, Constructed Wetlands, Rain Gardens, Permeable Pavement, Riparian Buffers, Urban Landuse Conversion)
    - Location of BMP
    - Drainage Area of BMP
    - Age of System
- Sewage Disposal Practices (GIS Layers)
    - Sewer Lines
    - Housing/Building Layers (with age of houses)
- Street Sweeping Practices
    - Extent and Frequency of Sweeping
    - Amount of Debris swept
- Pet Waste Program Information
    - Pet Waste Station Locations (Existing and Proposed)
    - Any ongoing educational or outreach efforts
- Streambank stabilization projects
- Stream Restoration Projects
    - Location, Length and Cost of Project
- Grant Funding Opportunities
- Ongoing or Future Watershed Plans

QUESTIONS:

Sewage Handling and Disposal:

If present, ask VDH to give an overview of their activities/programs to correct straight pipes and failing septic systems locally.

VDH is not present at this meeting. A survey will be sent to Virginia Department of Health to get their feedback.

The TMDL assumed a septic system failure rate of **3%** (Dan River TMDL) of the total septic systems in the watershed.

1) *In order to appropriately quantify the number of new systems or connections to public sewer that address septic system failures, do we need to adjust the estimated failure rate?*

   There has been no increase in sewer customer base.

2) *Should there be specific failure rates by locality/watersheds?*
   No comments provided

Straight pipe estimates during TMDL development:

Tables 3-21: Estimates of the Number of Septic Systems and Straight Pipes

Category	# Failing Systems	# People per Household	People Served	Flow (gal/day)	Daily Load (#cfu/day)
Septic Systems	189	2.47	464	34,837	1.3187E+10
Straight Pipe	421	2.47	1,034	77,561	3.0534E+12

3) *Does this number seem appropriate?* Straight pipe estimates during TMDL development were 421 (Dan River Bacteria TMDL). These estimates are based on a self-reported number from a question on the 1990 census. On the 1990 U.S. Census, people were asked what type of sewage disposal system that was associated with their home: sanitary sewer connection, septic system or "other". During TMDL development, the census data is interpreted the "other" to mean straight pipes. The 2000 and 2010 Census did not ask questions about sewage disposal. The houses included in this category are assumed to be disposing of sewer directly via straight pipes if located within 200 feet of a stream (Figure 3-20 in TMDL document). Percent of Houses within each County on public sewer, septic system, and other means.

County	% Public Sewer	% Septic Tank	% Other Means
Danville	88	12	1
Halifax	14	77	10
Henry	34	63	3
Patrick	7	86	7
Pittsylvania	8	86	6

4) *Is it appropriate to assume that all new development that has occurred since approval of the TMDLs (Birch Creek 2004, Dan River 2008) has been connected to the sanitary sewer system in some areas? If so, what areas? More development around the existing urban areas. 90,000 gallons hauled to plan last month. What about Portable toilets? They transport to local facilities.*
    a. Representative from Pittsylvania County in this group? - Chris A.
    b. A lot of wastewater goes to Danville Water Authority, but many areas choose not to connect.
    c. About 90,000 gallons coming into the plant per month

5) *Are there certain communities, subdivisions, etc. that could be referenced in the IP that generally have a higher number of septic system failures?*
   Westover Hills (annexed by Danville)

6) *Some counties in Virginia require homes within a certain distance of the sewer system to connect. Do localities in this area enforce this type of ordinance? If so, what is the distance to the sewer system that the ordinance addresses?*
   The City of Danville requires a connection if within 500 feet of a sewer line.

7) *Is there a need/interest/capability to add sewer to any areas?*
   There is perhaps a need in a new industrial park. WWTP capacity has plenty of room since all of the mills have shut down. The treatment plant is current permitted for 20 MGD and presently discharging 8 MGD.

8) *Are there any BMPs targeting undersized sanitary sewer or overflows (SSO's)?*

   No. The City of Danville completes routine maintenance with flusher truck once every two years. Danville knows where most overflows occur.

9) *Is there a need for public sanitary sewer education?*

   Yes, there is a definite need for public education to engage citizens. "Flushable" wipes have become a problem as well as oil and grease.

10) *If grant funds are obtained to cost-share on addressing straight pipes and failing septic systems which local agency/organization(s) would possibly be interested and best suited for this role? Southeast Rural Community Assistance Project (SERCAP), VDH, SWCDs, WPPDC, and/or DRBA? Do all of these have experience in managing grant funds?*
    a. SWCDs, municipalities, Planning Districts take on grants
    b. There is a lot reporting and management
    c. Who is best suited to take on funds? Usually SWCD and Planning districts for residential septic programs

Agricultural Programs and Implementation Locally:

*If present, ask NRCS/SWCD to give an overview of the **federal** agricultural programs that local landowners are utilizing (e.g., CREP, CRP, EQIP, etc.).*

No NRCS representative present

1) *What is the level of participation in these programs?* More interest than funds
2) *Is there adequate funding for these programs?* More funding is needed

*If present, ask the SWCDs to give an overview of the **state** cost-share program in their areas.*

1) *What is the level of participation in these programs?*
   Interest is high; however, there is more interest than funding available

2) *What is the estimate of farmers not participating in federal and or state cost-share programs locally?*
   There is not an accurate count for the number of farmers participating.

3) *How much cost-share funding does each District generally receive annually? Is there adequate funding for this program?*
   $200,000 is an average cost-share allocation for Pittsylvania SWCD. The district is unable to help everyone with limited funding.

4) *Are the Districts involved in tracking voluntary BMPs?* Should voluntary BMPs be included in the IP (means we would list certain BMPs and targeted numbers that could be implemented at landowner cost (e.g., stream fencing) with or without an incentive). [CL: CCI-SE-1 is not an incentive to implement fencing. It is an incentive for a farmer to maintain voluntary fencing for 5 years and for cost-shared fencing practices coming out of the 10-year life span requirement to be maintained for an additional 5 years.]
   Pittsylvania SWCD is not tracking voluntary BMPs. They have limited staff.

5) *How was the sign-up for 100% cost share for stream exclusion?*
   30-35 producers signed up. Roughly 20 left to fund

6) *How is participation in practices that would reduce loading through runoff?*
   There is a good bit of participation in the SL-1 practice which converts erodible cropland to permanent hay or pasture.

<u>Stormwater Programs (Urban Runoff)</u>

1) *Are there any efforts underway through local stormwater programs that are addressing bacteria and sediment sources that should be referenced in the IP?*
   - Drains to the river campaign on stormwater drains
   - Latest VPDES permit- first time Danville has had to monitor outfalls for E. coli. Wildlife contributing to runoff passing through plant.

2) *Are there any existing illicit discharges along sewer lines in the urban areas (even if they are been addressed through corrective actions)?*

   The City of Danville keeps track of illicit discharges. They are reported in Danville's MS4 Annual Report.

3) *Are there current stormwater BMPs that were constructed for runoff quantity control that could be retrofit for water quality improvement? Are there any existing designs and/or costs estimates for any of these BMPs?*

   Danville has 10. Most are extended detention basins.

4) *Are there areas where streambank restoration projects could be or are being implemented?*

- Camilla Williams Park -There is opportunity on some tributaries.
- Working on a demonstration buffer at the YMCA
- Apple Branch that comes out at the Biscuitville.
- Timberlake Drive.
- Diesel spill off Falling Creek.
- The worst erosion is occurring where tributaries are coming into the Dan River.
- Rutledge Creek by Corning is a potential site for stream restoration.

Pet Waste

1) *What is going on locally to educate about and or control pet waste?*

- Danville has targeted pet waste disposal areas, but this is an area for improvement
- There is a spot on Danville's website devoted to pet waste.
- DEQ has worked with watershed roundtable organizations and will do projects like pet waste stations or education.
- Pet waste stations on the river trail in Danville. Danville will send DEQ the pet waste stations locations
- Angler Park, Visitors Center
- Education campaign may be more effective

2) *How receptive would residents in concentrated residential areas be to such a campaign?*
   a. Not very receptive
   b. More urbanized areas would be more receptive
   c. Have to make it convenient for people or they won't do it.
   d. Need trash receptacles for people to through away pet waste

3) *Who can help identify where there are existing pet waste disposal stations in the impaired watersheds?*

   Localities know where they have installed pet waste stations.

4) *Are there some other dog walking areas where disposal stations and educational kiosks should be installed? (Parks, walking trails, etc.)*

   Riverwalk Trail, county parks, etc.

5) *Are there hunt clubs, kennels, other boarding facilities where dogs are confined locally long-term or either seasonally? Should these be considered as a potential source issue to address in the IP?*

   There is a new veterinary office being built. Veterinary offices are good starting places for educational campaigns.

6) *Which agency and or organization would be good to help with education to address this bacteria source? (VCE, Parks and Rec, veterinarians, others?)*

   It was suggested that Virginia Cooperative Extension would be a good partner to assist with pet waste education.

Other Bacteria Sources

1) *Are there other potential sources of bacteria that have not been mentioned that should be discussed?*

None mentioned

Integration with Other Activities and Local Planning

1) *Are there existing or planned activities, studies, planning efforts that should be referenced in the IP since these could possibly help with meeting IP goals?*

Regulatory Controls

We are required to identify in the IP regulatory controls in place that could be used to promote implementation. These include the state's Agricultural Stewardship Act and VDH's Sewage Handling and Disposal Regulations.

1) *Currently no septic tank pump-out ordinances – any in the works?*

None

2) *Any sewer extensions anticipated?*

None

3) *Any programs in place to control wildlife? Any anticipated?*

None

4) *Any pet waste (pickup) ordinances?*

None

5) *Any stormwater regulations?*

Yes, the City of Danville is an MS4.

6) *Are there other relevant regulations and ordinances?*

None were mentioned

Other Topics:

1) *Government Working Group representative to the Steering Committee? Volunteer?*

2) *Other Plans have quantified Erosion and Sediment controls (and in some cases "enhanced" E&S); would you share, in general, your locality's/entity's approach to E&S control?*
Danville is its own VSMP Authority. Danville conducts plan reviews and inspections. The counties opted out. Their review is done through DEQ.

3) *With regard to street sweeping, are there opportunities to modify frequency?*
Danville street sweeping occurs on 24-hour shifts. Danville street sweeping vehicles have Automatic Vehicle Locator system. The road length swept can be determined utilizing the locator system. Danville maintains its own roads.

4) *What alternative funding sources are available?*
None were mentioned

5) *Are there any additional educational needs which should be addressed?*
More stormwater education. River City TV is a great educational tool.

6) *Would it be possible to use local municipal mailings (utility bills, tax bills) or space on municipals websites, or through various town registers as an avenue for education on watershed cleanup, septic education [operation, maintenance], pet waste education?*
   Yes.

7) *Are there any additional or planned BMPs that we need to account for?*
   None were mentioned

8) *Are there any upcoming opportunities for outreach (i.e. any large gatherings of businesses) that we could piggy-back the water quality message on to?*
   - The month of May is "Make Danville Shine"
   - River Festival
   - Local running events
   - Danville Science Center
   - Wine/Beer Festivals
   - Rotary Groups

It was suggested to include the Parks and Recreation Department on the mailing list for meetings.

Contact James Moneymaker if you are interested in representing the government working group on the Steering Committee. The Steering Committee will review the draft TMDL Implementation Plan before it is presented to the public. The Steering Committee will meeting next spring after a second round of agricultural and residential working group meetings.

James.moneymaker@deq.virginia.gov
(540) 562-6738

Meeting Adjourn

Birch Creek and Dan River Watersheds TMDL Cleanup Plan

Agricultural Working Group

October 3, 2017
Danville Regional Airport, Eastern Conference Room

Meeting Attendees: James Moneymaker, Paula Main, Lucy Baker (Virginia Department of Environmental Quality); Susan Lindstrom, Ginny Snead (Louis Berger); Rick Brown (Halifax SWCD); Ralph Alderson

The agricultural working group will discuss ways to reduce bacteria coming from agricultural sources. The principal objective of this working group is to identify obstacles to implementation of practical solutions to reducing bacteria. This group will focus on identifying:

- Constraints to the implementation of BMPs
- BMPs that are both effective and affordable
- Alternative funding sources/partnerships
- The best strategies for reaching agricultural stakeholders

General questions and comments:

- 2008 study and 2017 IP why the time delay?
    - Depends on the group some TMDLs go straight to IP and some there is a lag because people need a break and implement BMPs on their own
    - Would be interested in seeing the data from within the last 10 years to see if we have better
- Any trend data to see differences between years?
    - Trend site on Sandy Creek
- Logical disconnects - current status <1% direct deposition in Birch Creek?
    - Remedy would be 87% reduction in direct deposition
    - Buffer included in report. What other BMPs could we do to get at 87% reduction?
- Are farms that are on impaired streams getting priority for cost share assistance?
    - Yes
- Who runs the 319 funding?
    - SWCD or municipalities
- Once implementation practices are put into place, are they checked?
    - Yes, random spot checks
    - Fencing is usually in compliance and watering trough issues
    - Stream exclusion for 10 years
    - SWCD have people signed up for cost share but no money to fund.
- Updating any CAFO numbers?
    - Will get updated numbers

  - No CAFOs for WLA but may be misrepresented on land
- Tobacco has been going away, what is replacing it?
  - Soybeans, or idol
  - A quarter going to cattle

Agricultural Questions:

1) *What is the current growth trend for agriculture in the area?* Do you expect to see significant changes in farming practices over the next 5-10 years?
   Less tobacco in the area. More small ruminant (goats, sheep). There are no dairies in Halifax County. Farms are producing row crows and some beef cattle.

2) *Are local cattle producers receptive to stream fencing and improving grazing management?*
   There is interest as long as there is a program to support it. There is more interest in grazing management.

3) *What barriers are holding back progress to implementing stream fencing and improving pasture management?*
   Funding. People are more so interested in a watering system versus simply fencing streams, but people are willing to fence streams to get a water system.

4) *Is there existing manure storage in the watershed? Is there a need for additional manure storage?*
   There is not a need for manure storage in Halifax County due to limited confined animal agriculture.

5) *Are there any problems with manure spreading on crop or pasture fields locally? What are the best BMPs to address this source?*
   No Class B biosolids within Halifax County. Setbacks are in place such that no NEW confined animal feeding operations (CAFOs) will be established in Halifax County. Check with permit staff to determine what CAFO permits are in the watersheds from the time the TMDL was established.

6) *Is there poor pasture or erodible cropland in the area that should be converted to forest?*
   95% of soils in Pittsylvania and Halifax are highly erodible. There is a need for better management.

7) *In general, are there practices that are more easily implemented and/or more appealing than other practices in this area?*
   Rotational grazing is more easily implemented. Education is needed to prevent over grazing.

8) *What is the best way to let farmers know about conservation programs?*
Virginia Cooperative Extension staff and mailings

9) *Are there any groups in the watershed that would be good resources for education and outreach? Is there a need for education and outreach on pasture management for horse owners or owners of other types of livestock? Who is best to disseminate this type of information?*
Cattleman's Association, SWCD, Farm Bureau, NGOs
There are more people raising goats and sheep rather than horses.

10) *How much of the farmland within the project area is leased?*
Less than 10% of land is leased for livestock production. Most land is leased for row crop production.

11) *Are there many horse owners in the area?*
No

12) *Are there certain BMPs that you feel would be most appropriate for the agricultural community in the watershed?*
Rotational grazing and pasture management, stream exclusion, nutrient management.

Contact James Moneymaker if you are interested in representing the agricultural or residential working group on the Steering Committee. The Steering Committee will review the draft TMDL Implementation Plan before it is presented to the public. The Steering Committee will meeting next spring after a second round of agricultural and residential working group meetings.

James.moneymaker@deq.virginia.gov
(540) 562-6738

Meeting Adjourn

Birch Creek and Dan River Watersheds TMDL Cleanup Plan

Residential Working Group

October 3, 2017
Danville Regional Airport, Eastern Conference Room

Meeting Attendees: James Moneymaker, Paula Main, Lucy Baker (Virginia Department of Environmental Quality); Susan Lindstrom, Ginny Snead (Louis Berger); Rick Brown (Halifax SWCD); Ralph Alderson

The residential working group will discuss ways to reduce bacteria coming from human and pet sources. The principal objective of this working group is to identify obstacles to implementation of practical solutions to reducing bacteria. This group will focus on:

- Ways to address/identify and eliminate straight pipes and failing septic systems
- Identify potential means of funding
- Determine educational tools that are most likely to engage watershed residents
- Evaluate ways to reduce bacteria from pet waste

Sewer Overflows:

1) *Are you aware of any public sewer areas that may smell of sewage or show other evidence of a sewer leak/overflow, especially during heavy rain?*
   None

On-Site Sewage Disposal:

1) *Are you aware of problems with straight pipes and failing septic systems in the area? Any particular areas?*
   Not aware of any problems

2) *If funds were available to assist residents with straight pipes and failing septic systems, what would be the best ways to notify people of such funds?*
   Halifax radio, local newspaper, local churches bulletins

3) *Is there an ordinance in Halifax County, Pittsylvania County, Patrick County, City of Danville, or the Town of South Boston that requires septic tank pumpouts/maintenance? Possibly during property transfers?*

   There is no ordinance in Halifax County. There are no representatives from other areas present.

- *How much does a septic system pump-out cost in this area? How many companies do this type of work? Look at companies bringing the pumpout waste to the wastewater treatment plant.*

  A pumpout will typically cost $130. There are a number of companies offering septic pumpout services. We should be able to get an estimate of how many companies take sewage to the Danville WWTP.

- *Is there a need for alternative systems? What are the regulations associated with alternative systems?*

  There is not a high demand for alternative systems. Soils typically perk well in most locations.

4) *Is there a need for education regarding the operation and maintenance of septic systems?*
   Yes, education would be beneficial.

5) *What are some local agencies and organizations best suited for this effort? Available programs?*
   Local Public Service Authorities, Town of South Boston, Tri-County Community Action Agency, etc.

6) *How should education be offered?*
   - Brochures?
   - Workshops/community meetings?
   - Public service announcements?
   - Neighborhood canvassing?
   - Other?

   Education would best be offered as a public service announcement.

Pet Waste Questions:

1) *Are you aware that pets (i.e. dogs) can be a significant source of bacteria entering surface waters in the state? (This is based on bacteria source tracking data collected by DEQ.) Are there hunt clubs, dog kennels, veterinary hospitals, boarding facilities that should be considered potential sources for pet waste bacteria?*
   Yes, people in more urban areas are aware that pet waste is an issue.

   Double Creek and Birch seemed to have a high number of pets versus the human population. We will need to check the numbers for Double Creek.

   The group mentioned that veterinary offices could be a source.

2) *Have you heard about the need to pick up and properly dispose of dog feces locally?*

There are a few pet waste stations available in Halifax although they are not always used or bags and not stocked.

3) *Are you aware of any localities in the watershed with a "scoop the poop" ordinance?*
   Not aware of any ordinance

4) *There are accessible pet waste disposal stations in the watersheds? If so, where are they located? (parks, schools, subdivisions, public space) Are there areas where people tend to walk their dogs where such stations could be especially useful?*
   There are not many pet waste stations in Halifax County.

   A station(s) at Virginia International Raceway could be useful.

5) *Are there any local education programs related to pet waste? (ASPCA, veterinarians, 4-H, kiosks, etc.)*
   There are no active pet waste education campaigns. It is important to keep reminding citizens that pet waste is an issue.

6) *How can we educate homeowners about the impact of pet waste? Would people use a pet waste digester?*
   Most people would probably not use a pet waste digester. Education is best accomplished through a campaign with mailings, flyers, outreach at public events.

Stormwater Questions:

This Cleanup Plan will address the need for some stormwater Best Management Practices to collect and treat runoff from residential and urban land areas that contribute to bacteria from pets, failing septic systems, and illicit sewage discharges. These may include rain gardens, bioretention filters, infiltration trenches, vegetated buffers along streams, rain barrels, etc.

1) *Do you know of any areas where flooding consistently occurs during heavy rains?*
   The Riverdale area floods frequently

   Halifax SWCD completed three rain barrel workshops in 2016.

2) *Have you seen any areas of severe bank erosion within the watersheds? If so, where?*
   No areas were specifically identified.

3) *Do you feel that the term stormwater is recognized by most citizens?*
   Probably not

4) *Have any of you implemented stormwater BMPs on your property to deal with runoff? If so, what practices?*
   Two citizens have rain barrels in this group.

5) *Are you aware of what riparian buffer zones are? How willing would your neighbors or other community members be willing to create or expand these zones?*
   There isn't much in the way of riverfront development in Halifax.

6) *Are there any public areas where you know of stormwater BMPS having been implemented? What practices? Where?*

Other Items for discussion:

1) *Are there any organizations or groups in the area that work on projects related to any of these issues (sewer overflows, sewage disposal, pet waste, stormwater management, stream restoration and cleanup) that aren't represented here?*
   Master Gardeners

2) *Is there interest in a watershed tour?*
   The group does not see there being interest in a watershed tour.

3) *What are some of the barriers to implementing water quality improvement projects in the watershed?*
   Funding is a barrier to implementing most BMPs.

4) *Is there a considerable amount of recreation that happens on the Dan river (tubing, boating, canoeing, etc.)?*
   The group mentioned a new boat launch that was recently installed utilizing funds received from the Dan River coal ash incident. There are people the use the river for fishing. There is a little canoeing. River access is limited.

Contact James Moneymaker if you are interested in representing the agricultural or residential working group on the Steering Committee. The Steering Committee will review the draft TMDL Implementation Plan before it is presented to the public. The Steering Committee will meeting next spring after a second round of agricultural and residential working group meetings.

James.moneymaker@deq.virginia.gov
(540) 562-6738

Meeting Adjourn

Birch Creek and Dan River Watersheds TMDL Implementation Plan

Second Combined Agricultural & Residential Working Group

March 13, 2018, 6:00 p.m. - 8:00 p.m.
Danville Regional Airport, Eastern Conference Room, Danville, VA

Meeting Attendees: Susan Lindstrom, Erin Hagan (Louis Berger Group); James Moneymaker, Paula Main, Ashley Wendt (Virginia Department of Environmental Quality); Rick Brown (Halifax SWCD); David Hoback, Leah Manning, Joe Bonanno (West Piedmont PDC); Hanna Lindsey, Amber Eanes (Pittsylvania SWCD); Bill McCaleb (Virginia Cooperative Extension); Raymond Cocke (Halifax USDA-NRCS)

- The meeting began at 6:00 p.m. with introductions
- James Moneymaker asked the group to think about the most common best management practices (BMPs) used in the area.

Review of Existing and Proposed BMP Memorandum:

Table 1: Existing Stormwater BMPs

- City of Danville submitted existing stormwater BMP GIS files to DEQ.
- LB was able to discern the BMP practices and was able to pull useful information out of the attribute tables.

Q: What is Filterra?
A: A Filterra system is a brand name manufactured bioretention BMP. Filterra systems are designed for use in developed sites such as parking lots, landscaped areas, etc. As stormwater runoff enters a Filterra system, the runoff flows through the proprietary media mixture contained in a landscaped concrete container.

- Ashley Wendt would like the category “Filterra” to be re-categorized into an existing category, such as “manufactured BMP”.

Table 2: Proposed Stormwater BMPs

- No comments
- James will reach out to some of the localities for feedback on the stormwater BMP numbers.

Table 3: Proposed Sewage Disposal BMPs

- In the original TMDL, the number of septic systems were estimated numbers.
- Louis Berger estimated the percentages of failures on those original numbers
- Louis Berger used the Roanoke River IP failure rates as a starting place for the Dan River failure percentage rates.
- James mentioned that he previously spoke with Dan Richardson (VDH), and Dan felt that the TMDL estimates for straight pipes were too high.
- Ashley felt that there may be a better way to estimate straight pipes.

- James felt that some of the sewer connections had already occurred and therefore would most likely not happen in the future. In general the sewer system is not expanding.
- RB-2 column should decrease. The number of public sewer connections seems too high.
    - James will reach out to the City of Danville and VDH to double check these numbers.
    - LB suggested to reduce these numbers by half.
- Ashley stated that she thought 319(h) money could not be used for sewer connection.
    - James explained that 319(h) funding can be used for public sewer connections; however, 319(h) funding cannot be used to extend the main line.
- Regarding the number of alternative systems, James will talk with VDH to see if this practice is used in this area and how often. The proposed numbers are already low.

Table 4: Proposed Pet Waste BMPs

- This table was generated based on estimates from GIS imagery.
- Perhaps we should add a table containing suggestions for possible pet waste station locations.
- Tobacco Heritage Trail- unknown if there are any pet waste stations.
- Berryville- there are no pet waste stations, but there is one near the parking lot.
- Edmunds Park Botanical Gardens, there is a pet station however people don't use it.
- James brought up the idea that pet waste stations can and have been vandalized in some areas across the state.
- Big Toby Creek-where is the river access location? Louis Berger explained that they examined GIS imagery to estimate where stations should be located.
- Virginia International Raceway and Birch Creek Motor Park locations were discussed for pet station location. Other possible locations include hunt clubs, kennels, and veterinarian offices.
- Ashley asked if pet friendly hotels and schools were the only buildings considered. Louis Berger's response was, yes.

Q: Should apartment complexes be considered?
A: Louis Berger responded most apartments that allow pets usually have their own pet waste stations, but maybe this should be considered.

- BMPs must be in the Implementation Plan in order for grant funding to be used for the practice.

Table 5: Existing Agricultural BMPs

- Data received from DCR BMP Tracking Program

Table 6: Proposed Cropland BMPs

- Pittsylvania County SWCD uses sod waterways, tree plantings, and SL-6 practices most often.
- There was discussion about why there are so many sediment BMPs included in a bacterial TMDL Implementation Plan. Ashley explained that there is research which states that bacteria attaches to sediment which can lead to higher bacteria loads. Ashley explained that the plan could state that the stream exclusion practices are a priority and the cover crop practices could be a secondary priority.

- Most tobacco land is already in no-till
- SL-1 should be higher for all of the watersheds.
- Rick Brown mentioned that the SL-15 practice usually has more acreage in the systems than the numbers in the table.
- SL-11 (Critical Area Planting) and FR-1 (Aforestation of Erodible Crop and Pastureland) should be added to the proposed cropland practices.

Table 7: Proposed Livestock Exclusion BMPs

- **Please include the units in this table.** Units should be expressed in "feet".
- The group expressed that the stream exclusion estimates seem high especially for Dan River. It was suggested that we reduce the exclusion estimates for Dan River. Louis Berger explained that the estimates include footage for both sides of streams. Estimates were based on GIS NLCD data. LB explained that they used the NLCD land use layer to differentiate the type of land and estimated pastureland and what needed to be excluded. If the stream appeared to have a buffer, exclusion was not needed.
- There is not much CREP sign-up in this area. When participants start to compare federal programs to state programs, they realize that they do not have to plant trees with the state program and usually do not go the federal route.
- SL-6 practice has a grazing plan component incorporated into the practice.
- Add WP-4 (animal Waste Control Facility)
- There was discussion that this is sometimes on both sides of the river, which would technically reduce the miles exclusion.
- James explained that the IP process is broken up into two or three stages, usually allowing 10-15 years for completion.

Q: Is North Carolina doing anything for this plan?

A: No

- VCE stated that it would be beneficial to both states if we could work together.
- James will reach out to NC and see if they are doing any work on Dan River clean-up
- DRBA may have information to share for the plan being that they work in both states.
- The Dan River Coalition was mentioned. Also a VA-NC Commission?
- Ashley suggested adding language in the plan stating what NC is doing towards clean-up
- James asked if the districts were using practices for 10-foot setbacks or only those using 35 feet?
- WP-2T should be reduced. Apply these reduced numbers to other practices such as SL-6 or LE-1T
- Halifax SWCD doesn't do any SL-6A, so this number should be reduced.

Table 8

- Increase the acreage for the SL-9 practice.
- Wet Detention ponds numbers seem high. These practices must be in the plan to meet the TMDL.

- LB also pointed out that the Wet Detention ponds number is representing acres treated, not actual acres within the pond.
- Stream Restoration BMP was missing from the list, does this Practice have a bacteria reduction component? LB doesn't have any bacteria reduction efficiency for this practice. The group felt like this should be added as a practice due to the fact that DRBA has done some stream restoration projects and may be willing to do future projects. Ashley is going to check literature for a bacteria reduction value in order for LB to be able to use in the reduction calculation.
- FR-3 needs to be reduced, suggested adding to the SL-9.

Table 5-x Dan River Subwatershed TMDL IP costs (LB needs to make sure that all the numbers form the actual BMP lists are carrying into this spreadsheet correctly)

- Rick Brown said that the SL-6 and LE-1T systems in his area are between $25,000-$35,000. Pittsylvania SWCD said that theirs are slightly higher than that.
- Vegetative Cover on Critical Areas (SL-11) should be reduced to $2,500
- Aforestation on Erodible Crop and Pastureland (FR-1) should be reduced to $200/acre
- Sod Waterway (WP-3) should be increased to $2,500
- Septic Tank Pumpout (RB-1) should be reduced to $175
- Pet Waste Station cost should be reduced to around $300
- Pet Waste Digester – Doggie Dooley Model #3000 available for $90 which includes starter bottle of tablets to break down waste.
- Rain Barrel costs should be reduced to $80 (Virginia Clean Waterways)

[Meeting Handout #1]

Memorandum

DATE: 12 March 2018

TO: James Moneymaker and Paula Main, VADEQ

FROM: Sue Lindstrom, Erin Hagan, and Raed EL-Farhan, Louis Berger

SUBJECT: Dan River and Birch Creek – Existing and Proposed Best Management Practices

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This memorandum presents the draft results of the Best Management Practice (BMP) estimates necessary to achieve the TMDL bacteria reductions for the Dan River and Birch Creek Bacterial Total Maximum Daily Load (TMDL) Implementation Plan (IP). The general approach to quantifying reductions from BMP implementation is to use unit area load from each land-based source of bacteria. The memorandum will present the proposed stormwater BMPs, the proposed residential waste treatment BMPs, proposed pet waste BMPs, and the existing and proposed agricultural BMPs (livestock exclusion, pasture/hay, and cropland).

Existing Stormwater BMP Summary

Table 1 shows existing stormwater BMPs within the Dan River and Birch Creek TMDL IP watersheds. Existing stormwater BMPs in the Cane Creek, Dan Rive, Fall Creek, Pumpkin Creek, Sandy Creek west and Sandy River south watersheds were taken into account when determining the proposed stormwater BMPs in these watersheds.

Table 1: Existing Stormwater BMPs (acres-treated)						
	Cane Creek	**Dan River**	**Fall Creek**	**Pumpkin Creek**	**Sandy Creek (west branch)**	**Sandy River (south)**
Detention	4.54	7.05	4.59	0.65	2.44	2.66
Extended Detention		5.97	6.18		62.50	0.96
Filterra		5.53			0.21	
Grass Swale		5.00				
Infiltration Basin		2.57				1.87
Infiltration Trench	0.42			7.20		
Manufactured BMPs		4.10			2.60	
Rain Garden		4.00				
Retention			7.04	6.81	62.50	
Underground Detention	2.50	11.27	1.37	0.99	2.82	

New Stormwater BMPS

Table 2 presents the stormwater BMPs that in total will reduce bacteria to the allocated loads presented in the TMDLs. A pet waste education campaign is applied to each subwatershed, which is predicted to decrease the bacteria load by 55%. For the remaining load, the strategy was then to evenly increase the number of stormwater BMPs until the needed bacteria reduction was met. Urban riparian zones were estimated using the stream and landuse layer in ArcGIS.

Table 2: Proposed Stormwater BMPs (acres-treated)								
	Bioretention	**Raingarden**	**Infiltration Trench**	**Manufactured BMP**	**Constructed Wetland**	**Detention Pond**	**Riparian Buffer (Forested)**	**Riparian Buffer (Grass/Shrub)**
Dan River	2000	2000	2000	1500	1900	1500	82	82
Miry Creek	100	100	100	80	100	50	1	1
Birch Creek	275	275	50	20	120	10	2	2
Birch Creek UT	20	12	10	11	16	6	0	0
Germy Creek	25	15	9	10	10	11	0	0
Big Toby Creek	50	28	25	26	2	0	0	0
Fall Creek	550	550	250	250	550	100	10	10
Lawless Creek	52	25	25	25	50	50	0	0
Sandy Creek (west branch)	350	350	250	250	258	230	5	5
Sandy River (south)	400	400	250	250	225	200	3	3
Stewart Creek	125	125	20	20	25	0	0	0
Sugartree Creek	35	35	35	30	30	20	1	1
Sandy River (north)	110	100	100	100	100	100	0	0
Tanyard Creek	30	30	10	10	30	17	0	0
Cascade Creek	75	75	60	30	70	20	2	2
Stokes Creek	100	58	50	50	55	50	1	1
Lawson's Creek	150	150	50	150	150	145	1	1
Powell's Creek	30	16	19	17	20	21	1	1
Byrd's Branch	10	10	10	9	6	4	0	0
Double Creek	25	25	22	22	24	0	0	0
Sandy Creek (east Branch)	100	100	50	50	75	50	0	0
Cane Creek	200	200	200	100	100	125	2	2
Pumpkin Creek	300	225	200	200	210	150	19	19

Proposed Residential Waste Treatment BMPs

Table 3 shows the sewage disposal BMPs recommended for each watershed. The number of BMPs was based on the percentage of failing septic systems and straight pipe estimates, which originate from the estimates used to develop the 2008 Dan River Bacteria TMDL.

The residential waste treatment BMPs were distributed using the 2016 Roanoke River TMDL IP percentages. Therefore, 10% of the total septic systems in the watershed are recommended for RB-1 (Septic Pumpout). The remaining distributions include 60% of the failing septic systems in the watershed (assumed to be 3% of the total septic systems per the TMDL) are recommended for RB-3 (Septic Repair), 25% of the failing septic systems and all of the straight pipes are recommended for RB-4 (Septic Install/Replace), and 15% of the failing septic systems are recommended for RB-5 (Alternative Waste Treatment System).

Using the GIS data provided by the City of Danville and other available data, a visual analysis was performed to determine the proposed sewer connections. Sewer connections are proposed for Dan River, Sandy Creek (west branch), Sandy River (south), Cane Creek, and Pumpkin Creek watersheds. The remaining watersheds are more rural which poses logistical problems for connection to sewer lines. **Table 3** presents all residential waste treatment BMPs. Corrections to straight pipes are included under the septic install/replace category (RB-4/RB-4P). Discussion from the first working group meetings indicated that some area sewer treatment plant(s) are close to capacity. This could have an effect on how many sewer connections are ultimately proposed.

Table 3: Proposed Sewage Disposal BMPs						
	Total Septic Pumpout (RB-1)	**Sewer Connection (Target Areas and RB-2)**	**Total Septic Repair (RB-3)**	**Total Septic Install /Replace (RB-4)**	**Total Alternative Waste Treatment System (RB-5)**	**Total**
Dan River	962	416	173	135	43	1,730
Miry Creek	49	0	9	7	2	67
Birch Creek	126	0	23	14	6	168
Birch Creek UT	12	0	2	1	1	16
Germy Creek	13	0	2	1	1	17
Big Toby Creek	28	0	5	3	1	37
Fall Creek	127	0	23	25	6	180
Lawless Creek	12	0	2	2	1	16
Sandy Creek (west branch)	113	230	20	17	5	385
Sandy River (south)	148	88	27	24	7	294
Stewart Creek	29	0	5	5	1	40
Sugartree Creek	16	0	3	3	1	22
Sandy River (north)	136	0	25	15	6	182
Tanyard Creek	100	0	18	12	5	134
Cascade Creek	146	0	26	16	7	195
Stokes Creek	22	0	4	3	1	29
Lawson's Creek	45	0	8	5	2	60
Powell's Creek	17	0	3	2	1	23
Byrd's Branch	5	0	1	0	0	6
Double Creek	41	0	7	4	2	54
Sandy Creek (east Branch)	64	0	11	7	3	85
Cane Creek	75	132	14	13	3	237
Pumpkin Creek	77	238	14	34	3	366

Proposed Pet Waste BMPs

Generally the most appropriate placement of pet waste stations would be in areas where pets are walked. ArcGIS was used to determine locations of pet friendly hotels, schools, and recreational areas that could be prime locations for pet waste stations. **Table 4** presents the number of proposed pet waste stations where feasible for each subwatershed. An education campaign is proposed for each impaired subwatershed (for a total of 23 educational programs).

Table 4: Proposed Pet Waste Stations

Subwatershed	Building	Campground	Park	River Access Location	Trail	Total
Big Toby Creek				1		1
Cane Creek					1	1
Dan River	4	1	13	6	14	38
Fall Creek			1			1
Pumpkin Creek			2			2
Sandy Creek (east branch)					1	1
Sandy River (south)	1	1	1			3
Total	5	2	17	7	16	47

Existing Agricultural BMPs

Agricultural BMPs installed since the TMDLs study were quantified using the Virginia Department of Conservation and Recreation's (VADCR) Agricultural Cost-Share Database. Existing cropland, pastureland, and stream exclusion BMPs are presented in **Table 5**. The following watersheds do not have existing BMPs: Pumpkin Creek, Germy Creek, and Lawless Creek.

Table 5: Existing Agricultural BMPs										
	Big Toby Creek		Birch Creek		Birch Creek, UT		Byrds Branch		Cane Cree	
BMP Type	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitte	A Inst
Aforestation of erodible crop and pastureland	9.2	10.58	28.4	28.4	26.5	26.5				
Alternative Water System										
Animal Mortality Incinerator										
Composter Facilities										
CREP Buffer Length Recording Practice										
CREP Grass filter strips										
CREP Grazing land protection	21333	282.02								
CREP Riparian Forest Buffer Planting	35.9	35.9								
CREP Wildlife Habitat Buffer Rent										
Extension of CREP Watering Systems										
Fescue Conversion/Wildlife Option	17.1	17.1	13.6	13.6						
Field Borders/Wildlife Option			1.7	1.7						
Harvestable Cover Crop										
Idle Land/Wildlife Option and Idle Tobacco Land			21.1	21.1						
Long Term Continuous No-Till Planting System										
Long Term Vegetative Cover on Cropland									30	
Nutrient Management Plan Implementation and Record Keeping										
Nutrient Management Plan Writing and Revisions										
Permanent vegetative cover on critical areas	4	14.5	2.5	2.5					0.8	
Protective cover for specialty crops	12	12	96.86	98.89	71	71	7.53	7.53		
Riparian Buffer Rent	35.9	35.9								
Septic Tank Pumpout					6	0				
Small Grain and Mixed Cover Crop for Nutrient Management and Residue Management										
Sod waterway	0.87	7.6	2.59	93.81					2.8	4
Stream Exclusion With Grazing Land Management	6619	118.23	15940	162.8	3734	41.57	1100	23.27		
Streambank protection (fencing)			600	3.27						
Three Year Small Grain Cover Crop										
total	28066.97	533.83	16706.75	426.07	3837.5	139.07	1107.53	30.8	33.6	7

Table 5: Existing Agricultural BMPs											
	Powells Creek		Sandy Creek (east branch)		Sandy Creek (west branch)		Sandy River (north)		Miry Creek		Sand
BMP Type	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benef
Aforestation of erodible crop and pastureland	8	8	115.69	116.2			2.68	6.8	15.4	15.4	
Alternative Water System											
Animal Mortality Incinerator											
Composter Facilities									1	0	
CREP Buffer Length Recording Practice											
CREP Grass filter strips											
CREP Grazing land protection							6150	271.2	5698	94.79	
CREP Riparian Forest Buffer Planting							15.43	15.43	4.84	4.84	
CREP Wildlife Habitat Buffer Rent											
Extension of CREP Watering Systems									38.53	38.53	
Fescue Conversion/Wildlife Option											
Field Borders/Wildlife Option											
Harvestable Cover Crop					794.5	794.5	195.14	195.14			
Idle Land/Wildlife Option and Idle Tobacco Land											
Long Term Continuous No-Till Planting System					361.8	361.8					
Long Term Vegetative Cover on Cropland			75.4	75.4	22.1	22.1	30	30	20.84	20.84	
Nutrient Management Plan Implementation and Record Keeping											
Nutrient Management Plan Writing and Revisions											
Permanent vegetative cover on critical areas			1	1.05			2	30.7			
Protective cover for specialty crops							7.5	7.5	18.8	18.8	
Riparian Buffer Rent							15.43	15.43	7.14	7.14	
Septic Tank Pumpout									2	0	
Small Grain and Mixed Cover Crop for Nutrient Management and Residue Management					126.6	126.6	27.48	27.48			
Sod waterway			2.12	11.03					0.24	2.5	
Stream Exclusion With Grazing Land Management			3000	81.7	2645	52	15809	170	26730	344.59	
Streambank protection (fencing)											
Three Year Small Grain Cover Crop					62	74					
total	8	8	3194.21	285.38	4012	1431	22254.66	769.68	32536.79	547.43	

Table 5: Existing Agricultural BMPs											
	Dan River		Double Creek		Fall Creek		Lawsons Creek		Stewart Creek		Stoke
BMP Type	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitted	Acres Installed	Acres Benefitte
Aforestation of erodible crop and pastureland	53.16	53.2	15	25			11.6	13			10.
Alternative Water System	45	45									
Animal Mortality Incinerator							2	0			
Composter Facilities											
CREP Buffer Length Recording Practice					2914	0					
CREP Grass filter strips					4.1	20					
CREP Grazing land protection	1500	77.6									
CREP Riparian Forest Buffer Planting	26.5	26.6									
CREP Wildlife Habitat Buffer Rent					4.1	4.1					
Extension of CREP Watering Systems	1.5	56.9									
Fescue Conversion/Wildlife Option	71.5	73.5					11.4	11.4			
Field Borders/Wildlife Option	3.7	3.7					8.1	8.1			
Harvestable Cover Crop											
Idle Land/Wildlife Option and Idle Tobacco Land	81.61	114.1									59.
Long Term Continuous No-Till Planting System											
Long Term Vegetative Cover on Cropland	11.08	11.08	45	45			7.7	7.7	9	9	
Nutrient Management Plan Implementation and Record Keeping											
Nutrient Management Plan Writing and Revisions											
Permanent vegetative cover on critical areas	4.62	6.12	1.93	2.48			0.38	1.14			
Protective cover for specialty crops	479.2	479.2	250	250							
Riparian Buffer Rent	26.6	26.6									
Septic Tank Pumpout											
Small Grain and Mixed Cover Crop for Nutrient Management and Residue Management	2334	2409.6									
Sod waterway					0.82	30.06					
Stream Exclusion With Grazing Land Management	40993	583.24	5781	190.65			6942	123.27	7457	120	**1022**
Streambank protection (fencing)											
Three Year Small Grain Cover Crop											
total	45631.47	3966.44	6092.93	513.13	2923.02	54.16	6983.18	164.61	7466	129	10289.

Proposed Cropland BMPs

The amount of cropland in each watershed (based on NLCD 2011) was relatively minimal. The general approach to cropland BMPs was to apply continuous no-till on an area of land, and in combination, have a small grain cover crop, and propose 5% of cropland to have permanent vegetative cover, utilize sod waterway and cropland buffer/field borders each (for a total of 15% of cropland under these practices). For some watersheds, the necessary reductions from cropland are being met by existing cropland BMPs put in place since the development of the TMDL. In these watersheds (Double Creek, Sandy River North, Sandy Creek West, Sugartree Creek, and Tanyard Creek), a nominal coverage is proposed for each appropriate BMP. **Table 6** presents the proposed cropland BMPs for each subwatershed.

Table 6: Proposed Cropland BMPs (acres-installed)					
	Continuous No-Till (SL-15)	**Small Grain Cover Crop (SL-8)**	**Permanent Vegetative Cover on Cropland (SL-1)**	**Sod Waterway (WP-3)**	**Cropland Buffer/Field Borders (CP-33 and WQ-1)**
Dan River	91	109	38	38	38
Miry Creek	20	0	2	2	2
Birch Creek	147	150	2	2	2
Birch Creek UT	0	0	0	0	0
Germy Creek	26	26	0	0	0
Big Toby Creek	71	77	3	3	3
Fall Creek	46	49	2	0	0
Lawless Creek	47	47	0	0	0
Sandy Creek (west branch)	1	1	1	1	1
Sandy River (south)	46	7	4	4	4
Stewart Creek	34	23	2	2	2
Sugartree Creek	1	1	0	0	0
Sandy River (north)	3	3	1	1	1
Tanyard Creek	2	2	0	0	0
Cascade Creek	19	6	1	1	1
Stokes Creek	43	43	0	0	0
Lawson's Creek	62	66	4	4	4
Powell's Creek	6	6	0	0	0
Byrd's Branch	9	6	1	1	1
Double Creek	5	5	1	1	1
Sandy Creek (east Branch)	10	8	1	1	1
Cane Creek	78	79	6	6	6
Pumpkin Creek	11	11	0	0	0

Proposed Livestock Exclusion Systems

Livestock exclusion systems were determined through GIS analysis using aerial imagery, stream networks and landuse. To distribute the proposed length of exclusion systems, the distributions from the 2016 Roanoke River Bacterial TMDL IP Parts I and II (10% CREP, 75% SL-6/LE-1T, 5% SL-6A/LE-2T/WP-2T) were applied. **Table 7** presents the proposed livestock exclusion systems for each subwatershed and by each practice. The average system length within the watershed is 2,845 feet. The numbers presented in Table 7 represent the number of systems necessary to achieve the reductions in livestock direct loads, assuming an average system length of 2,845 ft.

Table 7: Livestock Exclusion BMPs						
	CREP Livestock Exclusion (CRSL-6)	**Livestock Exclusion for TMDL IP (LE-1T)**	**Livestock Exclusion for TMDL IP (SL-6)**	**Small Acreage Grazing System (SL-6A)**	**Livestock Exclusion with Reduced Setback (LE-2T)**	**Stream Protection/Fencing (WP-2T)**
Dan River	39629	148609	148609	19815	19815	19815
Miry Creek	1854	6954	6954	927	927	927
Birch Creek	855	3206	3206	427	427	427
Birch Creek UT	220	826	826	110	110	110
Germy Creek	20	76	76	10	10	10
Big Toby Creek	1650	6189	6189	825	825	825
Fall Creek	683	2563	2563	342	342	342
Lawless Creek	37	138	138	18	18	18
Sandy Creek (west branch)	2327	8726	8726	1163	1163	1163
Sandy River (south)	3023	11335	11335	1511	1511	1511
Stewart Creek	798	2993	2993	399	399	399
Sugartree Creek	674	2526	2526	337	337	337
Sandy River (north)	2905	10896	10896	1453	1453	1453
Tanyard Creek	1484	5564	5564	742	742	742
Cascade Creek	2210	8288	8288	1105	1105	1105
Stokes Creek	343	1287	1287	172	172	172
Lawson's Creek	2561	9605	9605	1281	1281	1281
Powell's Creek	771	2890	2890	385	385	385
Byrd's Branch	69	259	259	34	34	34
Double Creek	512	1921	1921	256	256	256
Sandy Creek (east Branch)	303	1135	1135	151	151	151
Cane Creek	1266	4748	4748	633	633	633
Pumpkin Creek	122	459	459	61	61	61

Proposed Pasture BMPs

Vegetative cover on critical areas was proposed for 30% of pastureland in Dan River, Cane Creek, Cascade Creek, Lawson's Creek, Pumpkin Creek, Sandy Creek East, Powell's Creek, Fall Creek, Lawless Creek, Sandy River South, Sandy Creek West, Stewart Creek, Birch Creek, and Germy Creek. Reforestation of erodible pasture was proposed for 10% of pastureland in these watersheds as well. Then, pasture management was applied to the remaining unconverted land. When bacteria reductions could not be met with the BMPs listed above, an acreage of wet detention ponds was proposed. The varying percentages reflect the bacteria and reductions required. The remaining watersheds needed less (1% of pastureland in SL-11 and FR-1) to meet the TMDL. **Table 8** presents the pasture BMPs for each subwatershed.

Table 8: Proposed Pastureland BMPs (acres-installed)						
	Woodland buffer filter area (FR-3)	**Vegetative Cover on Critical Areas (SL-11)**	**Reforestation of Erodible Pasture (FR-1)**	**Pasture Management (EQIP 528, SL-10T)**	**Wet Detention Ponds***	**Grazing Land Management (SL-9)**
Dan River	6960	6960	11600	37585	20000	0
Miry Creek	70	70	71	702	0	0
Birch Creek	541	2163	569	541	0	0
Birch Creek UT	16	16	17	16	0	0
Germy Creek	89	267	99	891	150	115
Big Toby Creek	41	41	41	41	0	0
Fall Creek	822	1918	967	5481	925	0
Lawless Creek	140	419	155	1397	220	210
Sandy Creek (west branch)	391	1953	499	6173	0	0
Sandy River (south)	957	2870	1063	9567	2075	0
Stewart Creek	381	1143	423	3809	1025	0
Sugartree Creek	184	553	205	1845	285	275
Sandy River (north)	98	98	99	490	0	0
Tanyard Creek	34	336	374	2790	0	0
Cascade Creek	743	74	474	7432	0	0
Stokes Creek	36	36	36	36	0	0
Lawson's Creek	74	74	75	74	0	0
Powell's Creek	295	295	394	1063	250	0
Byrd's Branch	6	6	6	31	15	15
Double Creek	36	36	36	36	0	0
Sandy Creek (east Branch)	422	422	469	633	0	0
Cane Creek	681	1460	664	4866	725	25
Pumpkin Creek	55	164	61	546	75	75

*acres treated

[Meeting Handout #2]

Table 5-X: Dan River subshed TMDL IP Costs				
Agricultural				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Livestock Exclusion	CREP Livestock Exclusion (CRSL-6)	$27,000	14	$378,000
	Livestock Exclusion for TMDL IP (SL6/SL-6T)	$45,000	52	$2,340,000
	Livestock Exclusion for TMDL IP (LE-1T)	$21,000	52	$1,092,000
	Small Acreage Grazing System (SL-6AT)	$9,000	7	$63,000
	Livestock Exclusion with Reduced Setback (LE-2T)	$17,000	7	$119,000
	Stream Protection/Fencing (WP-2T)	$21,000	7	$147,000
BMP Type	**BMP**	**Cost (per acre-installed)**	**Acre-Installed**	**Total Cost**
Pasture	Woodland buffer filter area (FR-3)	$700	6,960	$4,872,160
	Vegetative Cover on Critical Areas (SL-11)	$5,000	6,960	$34,801,140
	Reforestation of Erodible Pasture (FR-1)	$1,000	11,600	$11,600,380
	Pasture Management (EQIP 528, SL-10T)	$75	37,585	$2,818,890
	Wet Detention Ponds (acre-treated)	$150	20,000	$3,000,000
	Grazing Land Management (SL-9)	$200	0	$0
Cropland	Continuous No-Till (SL-15)	$100	91	$9,060
	Small Grain Cover Crop (SL-8)	$30	109	$3,260
	Permanent Vegetative Cover on Cropland (SL-1)	$175	38	$6,660
	Sod Waterway (WP-3)	$1,600	38	$60,930
	Cropland Buffer/Field Borders (CP-33 and WQ-1)	$1,000	38	$38,080
Residential and Urban				
BMP Type	**BMP**	**Cost (per system)**	**Systems**	**Total Cost**
Waste Treatment	Septic System Pump-Out (RB-1)	$300	58	$17,520
	Sewer Connection (Targeted Areas and RB-2)	$9,500	N/A	$0
	Repaired Septic System (RB-3)	$3,600	8	$29,160
	Septic System Installation/Replacement (RB-4)	$8,000	9	$73,116
	Alternative Waste Treatment System (RB-5)	$16,000	2	$28,800
Pet Waste	Pet Waste Education Campaign	$5,000	3	$15,000
	Pet Waste Station	$4,070	0	$0
	Pet waste Composter	$100	11	$1,065.80
BMP Type	**BMP**	**Cost (per acre-treated)**	**Acre-Treated**	**Total Cost**
Urban	Bioretention	$10,000	2,000	$20,000,000
	Rain Gardens	$5,000	2,000	$10,000,000
	Infiltration Trench	$6,000	2,000	$12,000,000
	Manufactured BMP	$20,000	1,500	$30,000,000
	Constructed Wetland	$2,900	1,900	$5,510,000
	Detention Pond	$3,800	1,500	$5,700,000
	Permeable Pavement	$240,000	0	$0
	Vegetated Swale	$18,150	0	$0
	Rain Barrel (number of barrels)	$150	0	$0
	Riparian Buffer: Forest (acre-installed)	$3,500	82	$286,010
	Riparian Buffer: Grass/Shrub (acre-installed)	$360	82	$29,420
	Cistern	$1,000	0	$0
Stream Restoration				
Stream Restoration		**Cost (per linear foot)**	**Linear Feet**	**Total Cost**
		$300	#REF!	$0
Stream Stabilization		$75	#REF!	$0.00
			Total Subwatershed IP Cost	**$145,039,652**